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## Some Aspects of the Teaching of Radiological Physics<sup>1</sup>

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RADIATION THERAPY combines the aspects of an art, whereby each patient is considered as an individual problem, with various personal characteristics which must be taken into consideration, and of a science, in which a great deal of definite information is available. Clinical medicine alone can offer training in the first; radiological physics contributes largely to the second. Since an x-ray generator or a radium applicator is a physical apparatus, it is evident that it can do its best work only for those who understand its physical possibilities.

The American Board of Radiology, recognizing the importance to the radiotherapist of an acquaintance with fundamental physics of radiology, has required its candidates to pass an examination on this subject. It has, therefore, been necessary that residents and fellows in radiology receive instruction along these lines. There are no satisfactory textbooks, and few trained teachers, in this field. Much of the advanced training of prospective radiologists is more or less along apprentice or tutorial lines, and many of these students must learn their physics in a rather haphazard fashion, from short courses at meetings, from books and papers, and from informal discussions. Great credit is due

the many men and women who, in spite of such handicaps, have satisfactorily passed the physics examination.

It is generally conceded that, largely as a result of the activities of the Board of Radiology, doctors are increasingly better trained before becoming specialists in this field. In no part of their subject is this more evident than in radiological physics. Examinations have been conducted in this branch for seven years; during that time, failures have steadily decreased—and not because of increasing leniency on the part of the examiners. The average passing candidate at present has a definitely greater fund of knowledge and the ability to put this to practical use. In this connection, acknowledgment should be made of the value of the so-called refresher courses offered by the American Roentgen Ray Society and the Radiological Society of North America. Many men whose access to teaching institutions is limited acquire in these courses basic information which enables them to carry on alone to much better advantage. There has come to be less disconnected memorizing of definitions and isolated facts and more general logical effort to understand the field as a whole.

Year after year, however, as candidates come before the physics examiners for the Board, a definite percentage of them invariably present certain errors and misconceptions. Some of these are due, of

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30–Dec. 4, 1942.

course, to carelessness on the part of the student, but some are due to neglect or misplaced emphasis on the part of teachers or in the literature. It seems that an analysis of some of these stock difficulties, and some suggestions about overcoming them, should be useful to both instructors and students.

In general it may be said that too often insufficient emphasis is placed on practical applications of various points. Examples and problems and more examples and problems are essential. One hears a statement in a lecture, or reads it in a book, and thinks he understands it, but "the proof of the pudding is in the eating"; application of the general concept to the individual problem must be made. Such detail sometimes appears impracticable in short courses or in articles in journals, but each teacher should see that his students get it somehow, and the independent student must set the drills for himself and try to find advice if he is not satisfied with his efforts.

A further general statement can be made that the habit of keeping up with current literature is not sufficiently encouraged. A surprising number of candidates read no radiological journal regularly; some of them do not even know the names of the two leading American publications in this field, not to mention any foreign ones. Small informal journal clubs are very desirable from this point of view. They can be conducted in various ways, depending on the membership; the point is to start a habit of reading the journals devoted to the specialty.

These general remarks apply, of course, not only to physics, but to the entire field of radiology, and much more besides. To come to the topic of this paper, it may be convenient to consider the general subject of radiological physics under four main divisions.

1. The purely physical part, covering generation of x-rays, radioactivity, interactions of radiation and matter.

2. Measurement of quality and quantity. This includes calculation of dosage.
3. Calibrations and records.
4. Protection.

These are not, of course, clean-cut divisions; each merges into the others, but some such segregation is useful for student, teacher, and examiner.

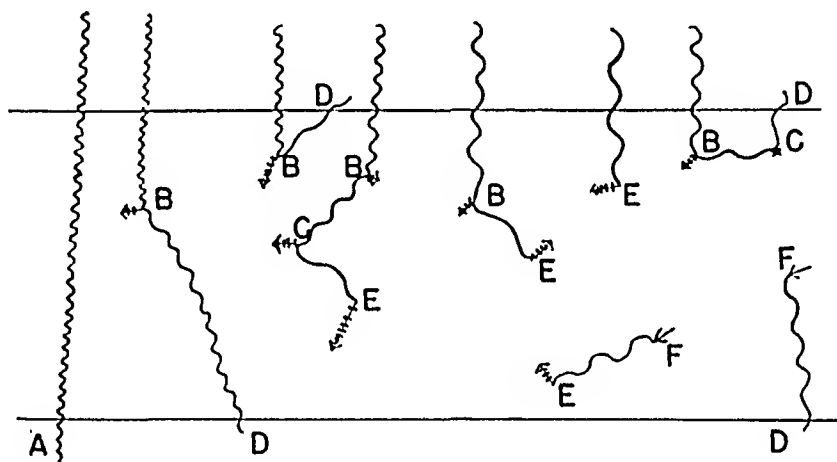
The material of the first part is quite adequately treated in various books and papers, and a reasonable understanding of x-ray tubes and circuits is generally encountered. Radioactivity, usually the stepchild in physics and in therapy, has received less attention, not because the material is not available, but rather because it is not emphasized. It is to be expected that phenomena of artificial or induced radioactivity will become increasingly important when the tremendous amount of research being carried out in these fields begins to find wider clinical application, and it is to the radiologist to whom members of the other specialties will turn for information. For the sake of his own pride, if for no other reason, he needs to know something about the subject.

When it comes to interactions of radiation and matter, and the practical applications thereof, books are less satisfactory. The interrelations between primary and secondary rays, scattering, ionization, etc., are not clearly pictured. For the understanding of measurement, dosage, and biological effects, it is essential to have such a picture. It must be remembered, however, that the true physical interpretations of these phenomena are complicated and difficult. It is not possible to give an explanation that is at the same time simple and really adequate. It is possible, however, to present some useful descriptive ideas. This is easier if both the wave and the photon aspects of x-rays and gamma rays are kept in mind—the short wave length, penetrating ray as a photon with a large energy quantum; the longer wave length, less penetrating ray as a photon of smaller energy quantum. It is

hard to picture a wave detaching an electron from its atom and thereby having its own direction and wave length changed; there is no such difficulty about a photon and its energy quantum. It is useful to consider what may happen to an assortment of x-rays passing through a sheet of matter, with the aid of such a diagram as Figure 1. Each x-ray is depicted as a single entity (a photon), but by means of a wavy line so that its associated wave length or penetrating power can be indicated. A few, such as *A*, may pass through unchanged, but most of them, at some level

atoms of the mass of matter, it in turn knocks other orbital electrons out of place, though seldom giving them much speed. For each such encounter, the swiftly moving electron loses some of its energy, until it is slowed down to the point where it can no longer be effective in this manner.

This removal of electrons from atoms is called *ionization*. The ionized state is normally very transient; an ionized atom attracts a free electron, the two recombine, and the atom is again complete. It is by means of this process of ionization that x-rays exert their effect on matter. While



## SCATTERING AND ABSORPTION OF X-RAYS BY MATTER

Fig. 1. Diagram indicating phenomena occurring in passage of a beam of x-rays through matter.

within the material, encounter an electron in an atom orbit. The result of this encounter is usually that some or all of the energy of the photon is used up in detaching the electron from its position in the atom and sending it off with a considerable velocity. This ejected electron, traveling at high speed, is exactly the same sort of particle as a beta ray from a radioactive substance, or an accelerated electron (cathode ray) in an x-ray tube, except that, in general, the beta rays have the highest velocities, the cathode rays next, and these *secondary electrons or secondary beta rays* excited in matter still less. As one of these secondary electrons drives through the

atoms or molecules are in the ionized state they can enter into chemical reactions not occurring under normal conditions. On the one hand, complicated molecules break down into simpler ones; on the other, synthesis of compounds takes place. Thus any change attributed to x-rays is directly due to the action of the secondary electrons in producing ionization.

To return to the photons themselves, it was stated above that a photon in interacting with an electron loses some or all of its energy. If it loses only part of it, it proceeds as a photon of less energy (or an x-ray of longer wave length) and in a direction which is different from that which



it originally took—that is, it is a *scattered* x-ray. The more energy it has lost, the greater the angle of scatter. Such encounters are shown at  $B - B$  in Figure 1. The scattered ray may be rescattered once or several times, as at  $C - C$ , until it finally either emerges from the mass of material, as at  $D - D$ , or undergoes a collision which takes all its remaining energy, as at  $E - E$ . It is not particularly important that the radiologist should know the names of these different types of encounters, so long as he has an idea of what is happening. It is, however, convenient to call the type which leaves the photon with some energy a *scattering*, or Compton,<sup>2</sup> impact, and the type in which it loses all its energy and ceases to exist a *photo-electric* impact.

Long wave length x-rays are more likely to undergo photo-electric collisions, short wave length rays, scattering collisions. This is to be expected, since the long wave length ray has less energy and can therefore more readily give up the whole amount to a single electron. In the case of scattering encounters, the shorter the wave length of the ray, the less likely it is to lose enough energy to be scattered through a very great angle. Thus the scattering laterally and backward is less, the harder the primary beam (*i.e.*, the greater the filter or the voltage). Back-scatter is known, however, to show a maximum for an intermediate quality; it decreases for higher voltages and filters, but also for lower ones. This latter is because the softer rays more readily undergo photo-electric collision, so that nothing is left of the primary ray to be scattered back.

Atoms which have lost photo-electrons are in a highly unbalanced condition, possessed of an excess of energy derived from the x-ray at the time of the encounter. When they pick up electrons and return to normal, they emit this excess energy in the form of *characteristic x-rays*, as at  $F - F$ . These characteristic rays are of longer wave

length than those which ejected the photo-electrons in the first place, and are emitted indiscriminately in all directions. For any particular element, characteristic rays are always of the same wave length, hence the name. This wave length is shorter the higher the atomic number of the element.

This picture has been discussed in considerable detail because, after its presentation, the student should find various phases of the interactions of radiation and matter easier to understand. The part that scattered radiation plays in skin and depth doses is clearer, as is the dependence of this contribution on the quality of the radiation and the amount of scattering material (size of field and thickness of irradiated part). The fact that, *within the ordinary therapy range*, the target-skin distance has no appreciable effect on back-scatter is explained. A beam of x-rays consisting of a particular mixture of wave lengths, on entering scattering material in a given direction, behaves in a particular manner, regardless of how far it traveled before it got there. For sources very close to the body, and widely spreading beams, the directions of many of the photons are, of course, quite different from those in a narrower beam from a more distant source, and changes in the scatter would be expected. But when beams are relatively narrow, and distances vary only between 40 and 80 cm., the changes in direction are too small to result in noticeable effect.

Another topic which is clarified by the preceding discussion is the nature of *filtration*. The manner in which a filter acts is one of the most frequently encountered misconceptions. The trouble is partly due to the name *filter*. To many this implies a strainer or a sieve, which transmits short rays down to a certain wave length, and holds the longer ones back. Asked what becomes of these longer ones, the student frequently has "never thought of that." When it is realized that the long wave length rays are the ones which most readily undergo the photo-electric type of collision,

<sup>2</sup> So-called because A. H. Compton first studied these encounters in detail, and in particular because he demonstrated the change of wave length in the scattered ray.

thereby ceasing to exist,<sup>3</sup> while the short wave length ones generally lose very little of their energy, the answer appears. There is no sharp dividing line. Some fairly soft rays may emerge from the filter; some fairly hard ones may suffer wide angle scatter and be lost from the transmitted beam but, *on the average*, the radiation which emerges from the filter is harder than that which entered it.

This emergent beam, however, contains a component due to the characteristic radiation of the filter, which may be quite soft. This component is removed by a thin layer of another metal which has little effect on the filtered beam, but removes the soft characteristic portion. Of course, the secondary filter contributes its own characteristic rays while eliminating the others; the final secondary filter (usually aluminum) has characteristic rays so soft they cannot penetrate the skin.

Concepts of the units of quality and quantity are often hazy. There is no virtue in memorizing a definition; the thing is to understand what the definition means. In the case of the half-value layers, as the means of specifying quality, the definition is usually recited; the method of obtaining the half-value layer for unfiltered radiation is usually understood, but the introduction of an initial filter adds a complication. This is easy to explain, but is frequently neglected. The idea that the half-value layer is simply a description of a property of the radiation seems to be harder to fix. There appears frequently to be a notion that something should be done with it; it is confused with the filter to be employed, or added to it. It must be realized that it is simply a label, to enable one to go into the proper table to find depth dose information, etc., just as the label 10 per cent acid or 40 per cent acid enables one to go to the proper bottle for the desired concentration of a chemical.

The *roentgen* is frequently confused with

the ionization produced by one roentgen in one cubic centimeter of air. It should be clearly brought out that the roentgen is not a unit of ionization; it is a unit of radiation quantity which is measured by means of ionization. The ionization chamber may have a volume greater or less than 1 c.c., as long as it is properly constructed to comply with the specifications for measuring in roentgens. It must be possible, however, to determine the volume. Then the total ionization in the chamber (or the saturation current resulting therefrom) divided by the volume gives the ionization *per cubic centimeter*, which in turn gives the number of roentgens in the beam at the place where the ionization was measured.<sup>4</sup> The area of the beam is not significant, *so long as the intensity is uniform throughout its cross-section*. At a given distance *in air* from a given source, a small beam has the same number of roentgens per minute as a large one, provided both are uniform. One roentgen produces the same number of ions in *every* cubic centimeter of air in a particular cross-section of the beam, as long as uniformity is maintained and scatter is avoided.

When the beam enters a scattering medium, uniformity is not maintained and the number of roentgens differs from place to place because of the different contributions from scatter. The roentgen should be recognized as a unit of an unfamiliar type; an analogy to the intensity of sound sometimes helps to clarify the idea. A noise is equally loud to one or a dozen hearers at the same distance from its source; the number of ears makes no difference in the intensity of the sound (just as the number of square centimeters in the cross-section of the beam makes no difference in the number of roentgens per minute). But if the sound has a duration of some seconds, and if there is a reflecting wall behind the audience, so that an echo enters, then the noise becomes louder because of the addition of

<sup>3</sup> Their energy does not cease to exist; it is used in the production of ionization, which ultimately does nothing but warm up the filter an imperceptible amount.

<sup>4</sup> In practice the radiologist seldom has to carry out this procedure. His ionization chamber has been calibrated and provided with a scale reading directly in roentgens.

Cu, he is bewildered. He has overlooked the fact that equal air doses do not necessarily imply equal skin doses. For 1,000 r *on the skin* of the two qualities under discussion, the doses at 7 cm. depth in a 50-sq. cm. field are 410 for 0.5 mm. Cu and 420 for 2.0 mm. Cu. These variations are the result of the difference in back-scatter. For 1,000 r in air, the skin dose for the 0.5 mm. Cu filter is 1,300 r, and for the 2.0 mm. Cu it is 1,210 r; 41 per cent of 1,300 = 530; 42 per cent of 1,210 = 510. Actually, for the particular problem here discussed, the variations are small and not clinically important. For greater depths, however, or when the use of more penetrating radiation (either from higher voltages or higher filters) is under consideration, the common custom of comparing on the basis of equal doses in air may lead to a false conclusion.

The influence of target-skin distance on depth dose is the stumbling block for many. They have learned that increasing target-skin distance increases the percentage depth dose. When asked why, they say: "Because of the inverse-square law." Many subjects have their particular hurdles; the inverse-square law is one of the worst in radiation physics. This is probably because it is so often learned merely by rote; the student tries to remember a set of ratios, can't tell which side up they go, and gets into trouble. Such an approach is unfortunate, for the matter is one of simple geometry, and much easier to understand than other aspects of the subject. It can well be introduced with the aid of a beam from a projection lantern or a motion picture projector. If the projection lantern is used, the bellows should be pushed together as far as possible. Hold a piece of plain white or quadrupled paper about 30 cm. from the lens, measure the size of the field, try to remember the brightness. Move it back 10 cm; the brightness is appreciably less, and the measured field is about  $\frac{(40)^2}{(30)^2}$  or 16/9 as large as before. Put it back to 30 cm. for an instant to recall the variation in bright-

ness from 30 to 40 cm., and then move it to 60 cm.; the field is 4 times as large, and the brightness obviously much less. Now move it away 10 cm. farther. The size of the field increases only slightly, considerably less than for a 10-cm. shift at the shorter distance; the difference in brightness at 60 cm. and at 70 cm. is also small. From this demonstration it is simple to go on to numerical examples, and here, as always, they should be practical. The fact that for twice the distance the intensity is one-fourth as great does not make it obvious that if an x-ray machine gives 50 r/min. in air at 50 cm., it will at 80 cm. give  $\frac{(50)^2}{(80)^2} \times 50 = 25/64 \times 50 = 19.5$  r/min. It is easy to remember which side up the fraction should go, if one simply remembers that, as the distance increases, the intensity becomes less.

Then the matter of finding the increase in depth dose for a particular distance shift and a particular depth is to be considered. First, it must be realized that for any particular set of physical factors the difference between the skin dose and the depth dose is due to three factors: (1) absorption of radiation by intervening tissue, (2) scattering of radiation by intervening and more distant tissue, (3) geometrical spreading of the beam according to the inverse-square law. If the diaphragm and x-ray tube are fixed in relation to each other, the irradiated area increases as the distance increases (recall the lantern beam). If, however, the size of the diaphragm is decreased as the distance is increased so that the field on the skin remains constant, the only difference in the geometrical distribution of the radiation is that due to the change in spreading of the beam, as in Fig. 2. Evidently for a very great percentage difference in distance (20 cm. and 80 cm., for example) the change in direction of some of the rays is considerable and would be expected to result in changes in distribution of scattered radiation within the body, and hence in changes in skin and depth doses. Within the limits of distances usually employed in therapy (40 cm. to 80 cm.), how-

ever, the change in direction of the rays is not enough to result in significant changes in scatter. In this case the effect of the inverse-square law can be studied alone; for a particular field and depth the absorption and scatter remain essentially constant. Consider, for example, in a pelvic field  $10 \times 15$  cm., at a depth of 12 cm., the effect of a change in distance from 50 cm. to 80 cm. Due to the inverse-square law alone, for the first distance, the dose at 12

cm. depth is  $\frac{(50)^2}{(50 + 12)^2} \times$  the skin dose,

and at 80 cm. is  $\frac{(80)^2}{(80 + 12)^2} \times$  the skin dose.<sup>6</sup>

The first fraction is 65 per cent; the second is 76 per cent. Hence increasing the distance has increased the 12-cm. depth dose in the ratio of  $\frac{76}{65} = 1.17$  or by 17 per cent.<sup>7</sup> If

200-kv. x-rays, hvl. 0.9 mm. Cu, are being employed, with a 150-sq. cm. field, at 50 cm. distance, the depth dose at 12 cm. is 36 r per 100 r in air. For 80 cm. it is  $1.17 \times 36 = 42$  r per 100 r in air. Of course, it requires  $\frac{(80)^2}{(50)^2} = 2.6$  times as

long to deliver the same air dose, but when it has been delivered, a 17 per cent better depth dose has also been delivered.

While the method of working out these percentages should be understood, it should also be understood that it is not necessary to carry out the arithmetic in practice, since tables are available for the purpose. These generally give, for various depths, the ratios between the doses for 50 cm. and those for other distances, since more 50 cm. data are available than for other dis-

<sup>6</sup> This fraction does not give the actual depth dose, but only the inverse square law component. The actual depth dose is the surface dose  $\times$  inverse square law factor  $\times$  absorption factor  $\times$  scatter factor. In the present example the absorption and scatter factors remain constant and can be neglected in the comparison.

<sup>7</sup> Note that this is the way to determine percentage improvement; not  $76 - 65 = 11$ . This is a type of error frequently encountered. When by some means the depth dose at a particular position is increased from 30 per cent of the skin dose (or of the air dose) to 33 per cent of it, this is a 10 per cent improvement ( $\frac{33}{30} = 1.10$ ), not a 3 per cent improvement ( $33 - 30 = 3$ ).

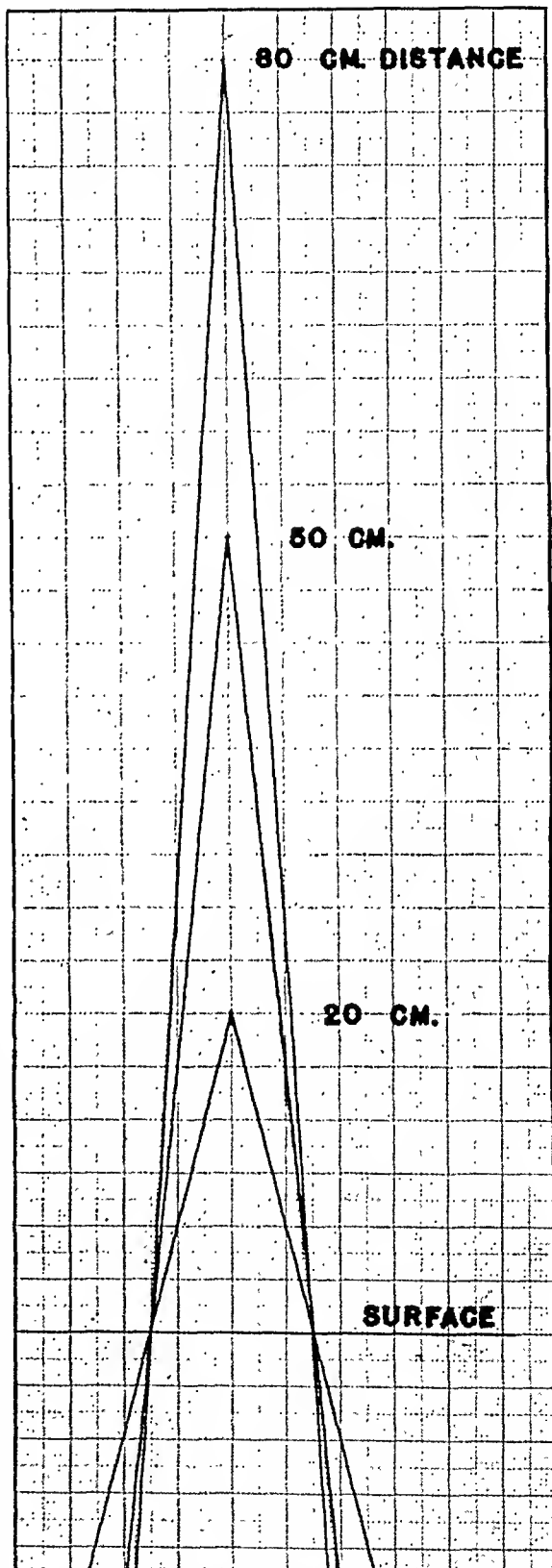


Fig. 2. Diagram illustrating change in spreading of x-ray beam within the body, for change in target-skin distance.

tances. In such a table, the reading for every depth, for 50 cm. distance, is 100. For distances less than 50 cm., the values are less than 100, for greater distances, more than 100. To use this table for the problem just worked out the long way, the procedure is as follows: In the column for 80 cm. distance, at a depth of 12 cm., the reading is 117. This means that the *percentage* depth dose at 12 cm. is, for 80 cm.

distance,  $\frac{117}{100}$  of what it is for 50 cm. dis-

tance. The  $\frac{117}{100}$ , or 1.17, is then applied to the 12-cm. depth dose for 50 cm. distance, as shown above.

Tables of this sort are usually satisfactory for distances within the ordinary therapy range. Before they are employed for any particular installation, for distances less than 40 cm., however, the calibrating physicist should be asked to check the range within which the inverse-square law is followed. For positions close to the tube holder, significant variations from this law are sometimes found. The young radiologist should be encouraged to consult with his physicist on such questions.

A surprising misconception with regard to the effect of increasing distance is quite common, namely, that the greater depth dose is, at least in part, the result of a change in quality of radiation because of the filtering effect of the additional air; in other words, that "distance acts as a filter." This error is encountered on an average of five or six times at each examination period, and, of course, leads to the question: "How much extra copper do you think 30 cm. of air would be equal to?" The answers are usually vague: "Well, quite a lot"; "More than 1/2 mm.," etc. The fact that 30 cm. of air are *in mass* equivalent to  $\frac{0.001293}{8.92} \times 30 \text{ cm.} = 0.04$  mm. Cu is a surprise.<sup>8</sup>

In spite of various difficulties in connection with determination of tumor dosage in x-ray therapy, there is, in general, an ap-

preciation of the problem. Even among the most poorly prepared candidates, there is usually some knowledge of where dosage information can be found, and how it should be employed. When it comes to the corresponding subjects in radium therapy, however, the matter is unfortunately in many cases just about where the x-ray dosage question was when all treatments were specified in terms of milliampereminutes, with a mention of spark gap, filter, and distance on the side.

The first answer of many candidates to the question as to how radium doses are specified is "in mg.-hr.," period. It is necessary to ask some further question, such as whether the dose is the same from 1,000 mg.-hr. from a large pack at 6 cm. distance and 1,000 mg.-hr. from a surface applicator, before the fact comes out that distance, filter, and size and shape of applicator must be specified. Even after that, too many, when asked again about tumor dosage, still stick to the statement that it is specified in mg.-hr. Asked about erythema doses or gamma-ray roentgens, the majority have heard of them, although within the last year, of the men applying for radiology or for radium therapy, at least five in the groups examined by the writer knew nothing whatever about them! Of those who have heard of the gamma-ray roentgen, the majority can define it, with more or less aid; that is, they can tell that the output from a point source, filtered by 0.5 mm. Pt at 1 cm. is 8.4 r., per mg.-hr. But at this point the lack of practical application too often becomes evident. Point sources are not generally used in practice, distances greater or less than 1 cm. are, and filters are not necessarily 0.5 mm. Pt.

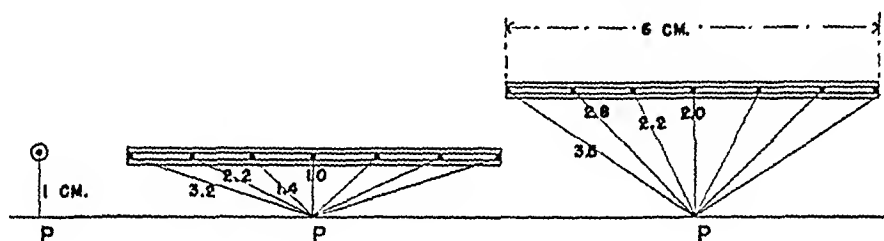
When the candidate is asked how he would go about expressing the tumor dose from a specified applicator, he is frequently at a loss. Many men say that the dose from any source at 1 cm. is the same as for a point source, and then apply the inverse-square law directly to obtain the dose at any other distance. The difference in dose from a point source and a tube is readily demonstrated by such a diagram as Figure

<sup>8</sup> 0.001293 is the density of air, 8.92 of copper.

3, and so is the reason why the inverse-square law is not directly applicable to such an applicator as a cervix tandem. Any radium source can be imagined to be made up of a number of point sources. The tandem 6 cm. long can be reasonably represented by 7 such, and if each of these is  $1/7$  of the amount of radium in the standard point source, then, since only one of the 7 is at 1 cm., and all the rest are farther, the total effect from all of them is, of course, less than from the standard point source. Furthermore, when the tandem is at 2 cm. instead of 1 cm. from the point  $P$ , only its mid-points are actually at these two distances. The ratio of doses from these is  $(1)^2:(2)^2$ , but for the others the ratios are  $(1.4)^2:(2.2)^2$ , and so on. If these

these topics in the examination on radiology. At the present time they are included, and the student should have some adequate instruction in them.

Questions in regard to calibration bring to light some strange facts. Some candidates know that their apparatus has been calibrated, but they can't remember when or by whom. Asked what they expect of the calibrating physicist, many don't really know. "He gives the technician the time to operate the machine" is an answer received not once but several times. As to the desirable frequency of calibration, some would have it daily, some yearly, or even less often, and are uncertain about any possible reasons for recalibration except the installation of a new tube. Few think it



EFFECT OF DISTANCE AND DISTRIBUTION OF RADIUM ON DOSE DELIVERED

Fig. 3. Diagram illustrating the effect of the size and the distance of a radium source on the dose delivered to the skin.

are all worked out, for the 7 points, and each multiplied by  $1/7$ , the sum is 0.48, that is, the ratio of the doses at  $P$  for the tandem 2 cm. away and 1 cm. away is 0.48:1, instead of 0.25:1 (or 1:4). This does not take into account the extra filtration acting on the radium near the ends of the tandem because its radiation goes through the tube walls obliquely; this effect is, of course, more powerful at the shorter distance (see Fig. 3). It can also be allowed for, if proper absorption curves are available; the final ratio for this particular case comes out to be 0.44:1. The literature contains satisfactory tables and charts for all such practical determinations.

This ignorance regarding radioactivity and radium dosage appears to be too often the result of neglect of this subject on the part of the teachers. This is not the place to discuss the advisability of including

advisable for them to be present when a calibration is done; they are satisfied to have their technician in attendance. This is all right, provided the radiologist knows what he wants from the physicist and has at some time discussed the matter with him. Both radiologist and physicist, however, would gain by more frequent discussions. The student in radiology should be encouraged to know as much as possible about what his physicist can do for him.

The keeping of records cannot be considered entirely a matter of the physical training of the student, nor yet entirely of the clinical. Possibly this is why it sometimes seems to get lost between the two, which is unfortunate. The keeping of records at the present time is in general vastly improved over what it was ten years ago. There are still, however, too many candidates who talk about spaces left un-

tances. In such a table, the reading for every depth, for 50 cm. distance, is 100. For distances less than 50 cm., the values are less than 100, for greater distances, more than 100. To use this table for the problem just worked out the long way, the procedure is as follows: In the column for 80 cm. distance, at a depth of 12 cm., the reading is 117. This means that the *percentage* depth dose at 12 cm. is, for 80 cm. distance,  $\frac{117}{100}$  of what it is for 50 cm. distance.

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In spite of various difficulties in connection with determination of tumor dosage in x-ray therapy, there is, in general, an ap-

preciation of the problem. Even among the most poorly prepared candidates, there is usually some knowledge of where dosage information can be found, and how it should be employed. When it comes to the corresponding subjects in radium therapy, however, the matter is unfortunately in many cases just about where the x-ray dosage question was when all treatments were specified in terms of milliampereminutes, with a mention of spark gap, filter, and distance on the side.

The first answer of many candidates to the question as to how radium doses are specified is "in mg.-hr.," period. It is necessary to ask some further question, such as whether the dose is the same from 1,000 mg.-hr. from a large pack at 6 cm. distance and 1,000 mg.-hr. from a surface applicator, before the fact comes out that distance, filter, and size and shape of applicator must be specified. Even after that, too many, when asked again about tumor dosage, still stick to the statement that it is specified in mg.-hr. Asked about erythema doses or gamma-ray roentgens, the majority have heard of them, although within the last year, *of the men applying for radiology or for radium therapy*, at least five in the groups examined by the writer knew nothing whatever about them! Of those who have heard of the gamma-ray roentgen, the majority can define it, with more or less aid; that is, they can tell that the output from a point source, filtered by 0.5 mm. Pt at 1 cm. is 8.4 r<sub>x</sub> per mg.-hr. But at this point the lack of practical application too often becomes evident. Point sources are not generally used in practice, distances greater or less than 1 cm. are, and filters are not necessarily 0.5 mm. Pt.

When the candidate is asked how he would go about expressing the tumor dose from a specified applicator, he is frequently at a loss. Many men say that the dose from any source at 1 cm. is the same as for a point source, and then apply the inverse-square law directly to obtain the dose at any other distance. The difference in dose from a point source and a tube is readily demonstrated by such a diagram as Figure

<sup>8</sup> 0.001293 is the density of air, 8.92 of copper.



tion from this secondary radiation is provided.<sup>11</sup>

Very important and very much neglected is instruction in the matter of protection in diagnostic radiology, particularly from the point of view of the patient. Few candidates appear to have given any consideration to the amount of radiation received by the patient in fluoroscopy or radiography. Such information has not been readily accessible before this year, but with the publication of Braestrup's detailed study in *RADIOLOGY* for February 1942, there is little excuse for this lack of knowledge. It is true that accidents in diagnostic radiology, and particularly in fluoroscopy, happen more often at the hands of the non-radiologist. It is highly desirable, however, for everyone in the specialty to realize, for instance, that under ordinary circumstances a single 100-milliamperesecond radiographic exposure at 80 kvp. 0.5 mm. Al filter, and 50 cm. distance, delivers about 6 r to the patient's skin and that in fluoroscopy the dosage rate to the patient is frequently more than 20 r per minute. Knowledge of this sort, combined with a small amount of reading on possible genetic damage resulting from small doses of radiation, may save many individuals from extensive diagnostic procedures whose importance is not certain.

Other studies of the biological effects of radiation—radiosensitivity, recovery, etc.—do not properly come under the subject of this paper, and will be mentioned only to point out that these are also topics which may get lost between instruction in clinical radiology and in physics. This is a field in which the student should be especially encouraged to keep in touch with periodical literature.

This paper does not purport to offer an

<sup>11</sup> The writer has seen a case where a shield of this thickness of lead, about 2 cm. wide, was used to separate two fields on a chest. The reaction under the lead after a part of the series of treatments had been given was sharper than that in the middle of the exposed portion. This must have been due to secondary radiation. The filter was increased to three layers of the  $1/32$ -inch lead, reducing the transmitted beam to less than 1 per cent, the inner surface of the shield was coated with collodion, and the reaction on the covered skin disappeared, although the treatment was carried on.

outline for the teaching of radiological physics. Its purpose is to point out, on the basis of the records of candidates before the physical examiners for the American Board of Radiology, certain topics which should apparently receive more attention during the training period, and to suggest methods for presenting some of the material. It is in no wise to be interpreted as a sweeping condemnation of present teaching in radiological physics. Many candidates have no difficulty whatever with any of the subjects herein discussed, and the percentage of well informed men is increasing. On the other hand, the points brought out have not been selected on the basis of isolated or even scattered cases, but as the result of errors recurring with each set of candidates, and not in those whose preparation is obviously inadequate, but in borderline cases, and even sometimes in those who make a passing average. It does not represent the opinion of a single examiner; the material here presented has been discussed in some detail with several physicists who have acted for the Board of Radiology. It is not meant to be exhaustive, but rather suggestive; teachers, candidates, and examiners will doubtless think of other topics which might well have been included.

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#### DISCUSSION

George W. Holmes, M.D. (Boston, Mass.): I have had the privilege of reading Dr. Quimby's paper and I have been very much impressed with the value of it. I think she has set an example which other examiners on our Board could well emulate. She has gone over the weak points in the candidates and she has pointed out the errors in their instruction as well as the errors of their studies and has then suggested methods by which these can be remedied. That is a very desirable thing to do.

It is an old custom among debating clubs, when one is asked to discuss something of which he knows very little, to broaden the subject and get on to something that he can talk about. That is what I am going to do. I am going to discuss briefly the teaching of radiologists in general.

The methods best suited to teaching in the medical specialties should not be confused with those used in colleges or public schools. In the latter group, the selection of the students plays a minor role and success depends largely upon the teaching ability of the instructor. In graduate medical teaching, on the other hand, selection is of the greatest importance, and success depends to a much greater extent upon the ability of the student. Furthermore, to be successful in their chosen fields, these men must remain students all their lives. The problem is thus quite different from that in academic teaching. The success of the teacher in the medical specialties will be predicated upon his being a man who, by his personality and achieve-

ment, attracts the best students. If, in addition to this, he is in control of ample teaching material, he will succeed even though from an academic standpoint he might be a very poor teacher.

If this is true—and I believe it is—the first problem is to attract the right men to our specialty. I think that this is perhaps the most important thing in graduate teaching.

The instructor must, by example, convince the student of the value of painstaking work, of follow-up observations, and familiarity with the current literature. Once these habits have been thoroughly established, good work is assured and the student will continue to accumulate knowledge long after he has finished his so-called instruction. Students who receive this type of training may not win high marks in examination, and their knowledge at any time may be spotty, but it is my firm belief, based on considerable experience, that in the long run they will make the best doctors.

I agree entirely with what Doctor Quimby has said in regard to the fault of the teachers. There is no doubt about that, but as a rule—and this is the only alibi that I can give—the teacher, a physician in charge of radiology in a hospital, is not primarily interested in physics and for this reason the interest of the students is not stimulated. In my opinion, a few months' work with an able physicist during a student's residency will do more to impress him with the importance of this subject than lectures or quizzes by the head of the department.

The vast amount of fundamental work done by such physicists as Doctor Quimby has greatly simplified our problem and it is no longer necessary for the radiologist to carry out complicated procedures in every case. But as Doctor Quimby has said, he should know the underlying principles which govern dosage and he should be familiar with the recent literature.

H. M. Parker, M.Sc. (Seattle, Wash.): I should like to appeal to Doctor Quimby to use her influence in correcting quite a pernicious habit, that is, the use of the expression "r units." I think it is about time that we realized that the roentgen is itself a unit.

Edith H. Quimby, Sc.D. (*closing*): I agree with Doctor Holmes that it is indeed not at all necessary to carry out complicated mathematical procedures in every case. On the other hand, when the unusual patient comes in, about whom we want to know something—say, for instance, how we can in this particular instance give just the extra amount of radiation—we want to know all the tricks by which we can do this, and that we cannot know if we have done nothing but sit and listen to a series of lectures by a physicist.

It is true that the physicist can give most of this information, but the physicist must be closely in touch with the clinical problems and be able to demonstrate these particular clinical points, not

necessarily with a patient present, but with all the facts concerning a particular patient before him.

I think this has been one of the difficulties about a number of able physicists who have tried to help out in the teaching of radiology: the radiologists have not insisted that the physicist become more familiar with the clinical aspect of the work. I would urge all of you who have physicists helping you, and particularly physicists who have not had a great deal of contact with the clinical side of the subject, to get them to come into your departments occasionally and observe some actual treatments. They do not need to become radiologists any more than

the radiologist needs to become a physicist, but there should be closer co-operation between the two in most instances.

May I say in answer to Doctor Parker's comment that I have for many years been carrying on a campaign against the use of the term "r units." I have repeatedly said: "We don't say a person is so many feet units high. Why should we say that a dose of radiation is so many r units?" This is something which has unfortunately become second nature to a great many people, but perhaps, if enough of us continue to crusade about it, we can bring about a cure.



# Limitations of Physics in Radium Therapy<sup>1</sup>

H. M. PARKER, M.Sc., F. Inst. P.

Tumor Institute of the Swedish Hospital, Seattle, Wash.

THE PROBLEMS of greatest interest to the hospital physicist are not necessarily those of the greatest practical importance. It is therefore well to review the field occasionally to decide whether one's activities are properly directed. A favorite problem has been the evaluation of gamma radiation in terms of roentgens. Although this evaluation was logically desirable, it has to be conceded that radium therapy *per se* has gained little from it. Another class of problems is concerned with the methods of distributing radium to obtain uniform and calculable irradiation. This paper is to discuss this class with special reference to the solutions offered by Paterson and Parker (1, 2, 3).

In the first place, absorption and scattering of gamma radiation in tissue are small enough to justify their deferment as a later correction. It is then possible to set up a mathematical theory. The problem can be defined as the uniform calculable irradiation of a prescribed region of tissue without the over-irradiation of other parts. There is a sharp differentiation between interstitial and superficial arrangements. In the former, the prescribed region is clearly a certain volume of tissue. In the latter, although there is still a volume of tissue to be adequately irradiated, one particular layer, the skin, requires more critical treatment than the rest. The region of uniformity is restricted to a single surface. Approximate uniformity is acceptable in the depth.

Under these conditions it appears that the operation of fluid distributions of radium for the interstitial case can be made to give irradiation as uniform as desired. Inasmuch as all distributions except the most symmetrical have to be evaluated by numerical integration, the

actual labor of determining the solutions would be prohibitive.

For superficial arrangements manipulation of two-dimensional sheets of radium is sufficient. The problem is always soluble for plane surfaces. Exact solutions can be obtained for many classes of regular curved surfaces, but irregular curves are not amenable to treatment. It should be observed that even for the simplest case of a plane circle it is impossible to achieve uniformity under the premises originally implied in the Paterson-Parker system, namely, that the periphery of the radium arrangement coincides with the normal projection of the treated area. This is self-evident because, for small rings, complete peripheralization of the radium still leaves the dosage rate high in the center. The present definition overcomes this by the artifice of having the "treated area" larger than the "prescribed region."

The Paterson-Parker system falls short of the mathematical ideal by permitted tolerances. It has to be investigated whether these tolerances are acceptable in view of other errors in radium therapy, or whether a more rigid solution should be sought.

The interstitial case is easily dismissed. Instead of operating with a generalized fluid, two density regions were chosen and general distribution propositions set up to a tolerance of  $\pm 10$  per cent. The fluid was then condensed to discrete sources. The distribution remained good except around the individual foci. These regions were confidently ignored on clinical grounds, because it was possible with weak sources to keep the dosage below the necrotic level, while the balance of the tumor area was adequately irradiated. It is evident that in this field physics is well ahead of clinical practice. The limitations of good implantation become:

1. The number of sources that can be

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

introduced without excessive trauma.

- 2. The skill with which they are inserted in postulated positions.
- 3. The reconstruction of the implant for accurate dosage calculation.

The development of the dosage system for external applicators was quite different. A direct approach was made with rings and straight lines of radium, rather than the mathematically more satisfying fluid sheets. In effect, the selected tolerance of  $\pm 10$  per cent represented one solution of the condensation of exact sheet distributions to line arrangements. The choice of  $\pm 10$  per cent tolerance was entirely arbitrary, and as it would be theoretically possible to reduce the tolerance almost to zero, it has to be determined whether other considerations warrant such a variation. As soon as the mathematical system is modified by practical details it becomes impossible to generalize. Examples have to be selected which illustrate either average or the most unfavorable circumstances as required.

A perfect distribution would be modified by absorption and scatter in tissue, and it would be unwise to elaborate a system to closer limits than the changes due to these causes. Roberts and Miss Honeyburne (4) have studied the ease of a radium ring. If the ring was fully surrounded by scattering medium the dosage rate was equal to that in air. When the ring was at or near the surface of the medium there was a net absorption of 4 per cent per centimeter depth from the ring. The author has found comparable though smaller effects in a series of clinical applicators. Scatter is more complete along the axis, so that central dose in any parallel plane tends to increase relative to the peripheral dose. Roberts and Honeyburne suggested that this would increase the ratio of diameter to skin distance for the ideal circle from  $2\sqrt{2}$  to 3. It seems more probable from their own measurements in air that most of the difference was due to oblique filtration. The author has used a ring of gold seeds, and later a single rotating source,

and has obtained close agreement between calculated and air-measured values. Changes with back-scatter were of the order of 2 per cent. The actual dose over a skin surface will depend on the construction of the applicator—whether the radium tubes are essentially in air or at the surface of a wax block. With the present methods of using radium there might be an error of perhaps 5 per cent in the quoted dose.

The effect of substituting discrete radium tubes for the long lines or rings used in the original system has been discussed (1) and preliminary rules given. The basis for these rules was that the variation thus introduced should not exceed the original variation. For example, the replacement of a ring by a number of gold seeds was designed to keep the circumferential variation less than the radial variation. Table I shows this for some rings. The rule was simplified to the requirement that the distance between sources should not exceed the skin distance, a somewhat more stringent rule.

TABLE I: NUMBER OF GOLD SEEDS REQUIRED IN A RING OF DIAMETER  $d$  AT RADIUM-SKIN DISTANCE  $h$

$d/h$	2	3	4	5	6
Radial variation	$\pm 5\%$	$\pm 3\frac{1}{2}\%$	$\pm 2\%$	$\pm 5\frac{1}{2}\%$	$\pm 8\%$
Number of seeds by Rule 1	6	8	10	10	10
by Rule 2	6	10	13	16	19

- Rule 1. Circumferential variation shall not exceed radial variation.
- Rule 2. Distance between seeds shall not exceed  $h$ .

The combined variation in a practical case can exceed the  $\pm 10$  per cent tolerance. In fact, the method of regulating the number of sources is illogical to the extent that arrangements initially poor are allowed greater laxity. The rules for large areas, especially rectangles, could well be improved. In general, with applicators commonly used, the use of discrete sources *per se* need add little or nothing to the existing error. Oblique filtration, a necessary corollary of discrete sources, merits separate discussion.

The original system took cognizance of

oblique filtration only in special treatments with long single sources. It was believed that the effect in most cases would be less than that of other inherent errors. This belief was doubtless encouraged by the complexity of oblique filtration calculations, and in review it

effect in many cases. Figure 2 shows an extreme case of a square 10 × 10 cm. at 1 cm. distance. The reduction by oblique filtration was calculated for different filters at two points (A and B). Allowance was made for the normal filtration reduction. At 1.5 mm. Pt the general dose level fell

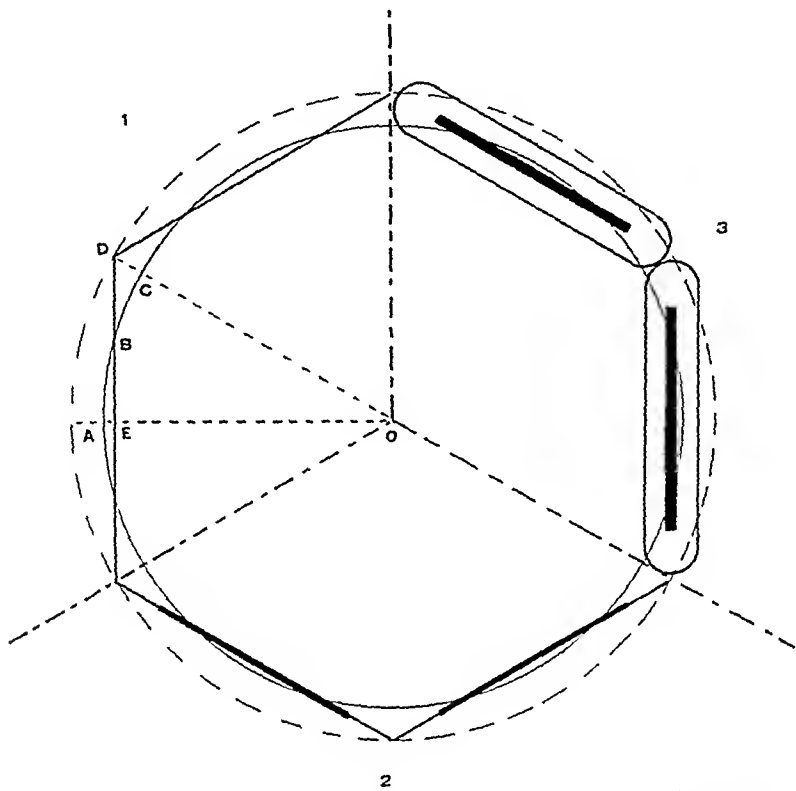


Fig. 1. Six 6.66-mg. tubes as a hexagon. Distance 14 mm. (1) Location of calculated points. (2) Tubes without platinum wall. Filtration correction for 1.5 mm. Pt. (3) Real tubes giving rise to oblique filtration.

	DOSAGE RATE (r/hr.)	
	No Oblique Filtration	Oblique Filtration
A	47.7	45.4
B	46.6	44.6
C	45.7	44.0
D	43.6	40.6
E	48.4	46.4
O	47.5	47.5

cannot be completely substantiated. In all cases the dosage rate in some parts of the irradiated area will be reduced by oblique filtration. Figure 1 illustrates a familiar example of 6 radium tubes as a hexagon. Near the center of the treated area the reduction in dosage rate is negligible, but near the periphery it is of the order of 4 per cent. This is typical of the

some 10 per cent below the direct value. Such a change should be corrected. Calculations with radium tubes are based on the assumption that the tubes are properly filled. The total radium content should be certified to approximately 1 per cent. The actual strength of modern tubes should be within 2 per cent of the nominal value. These values remain cor-

rect unless the tubes are grossly mishandled to produce a major radon leak, under which conditions it would be simpler to seek a new technician rather than a new dosage system. Nevertheless, H. D. Griffith (5) has demonstrated that needles may be so badly loaded that the radiation

Curved surfaces are not amenable to good mathematical treatment, and they are also less satisfactory in clinical practice. The system rules are entirely empirical. For convex areas, for example, they depend on the spread of the radium over a larger area to compensate for the increased

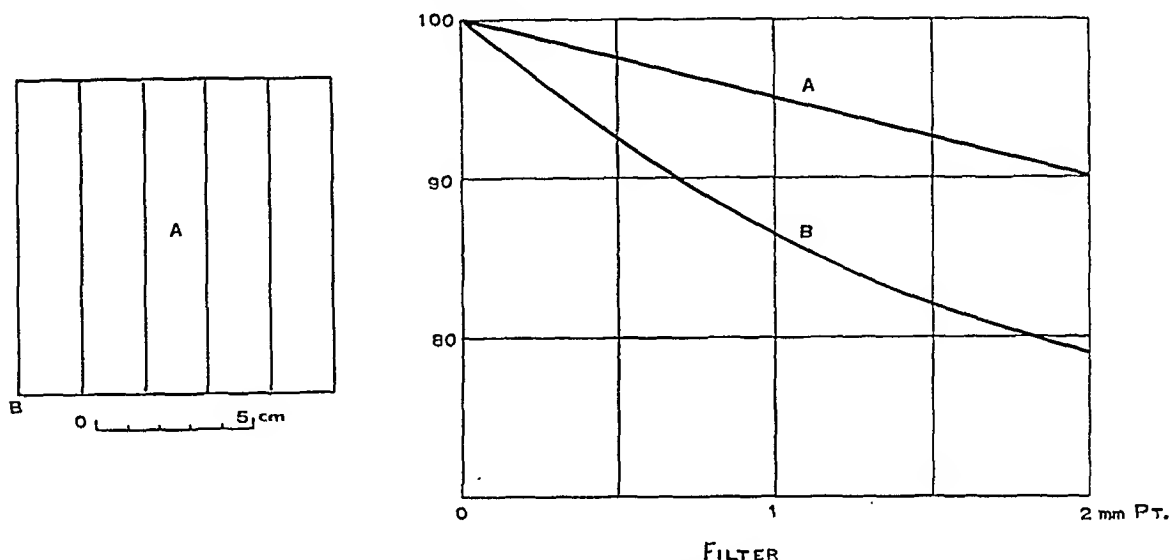


Fig. 2. The graph shows the relative dosage rates at points A and B in the treated area of a 10-cm.  $\times$  10-cm. rectangle, for different radium filtration, after the routine filtration correction has been made.

pattern is seriously disturbed. He chose four bad needles to make an applicator, compared this experimentally with four good needles, and shows the striking results in an illustration.<sup>2</sup> The effects of bad packing could clearly outweigh other errors discussed.

Radium tubes should be examined for packing initially, and again after one or two years, by autoradiograms. The eye can detect packing faults of the order of 20 to 30 per cent. Photometry would be preferable. Griffith's applicator has been reconsidered with relative strengths in the two halves of 1.2 to 1 and 1.4 to 1. Figure 3 shows the dose along diagonals at 1.5 cm. (to conform to the 2h rule). At 1.2 to 1 the error is not important. Nor is it excessive at 1.4 to 1 when the improbability of so unfavorable an arrangement is considered.

<sup>2</sup> In the interest of wartime economy, the reader is referred to Griffith's article to determine the details of the packing error.

dosage rate due to cross-fire. The compensation is surprisingly good over the regular curves that have been investigated. Nevertheless, certain special cases give results not within accepted standards. The most familiar case is the lip mold, as in Figure 4. Comparison of the dose with that over the equivalent plane indicates an increase in some regions of 15 per cent. Here a curve is followed by two planes not expanded by curvature. The difficulty can be met, after the manner of Murdoch and Stahel (6), by an individual calculation, or more readily by substituting two parallel planes for the curved mold. Concave areas are not well treated when the applicator area is much less than the treated area. Treatments with small skin distance or treatments at the radius of curvature of a part are sound.

Another difficulty, present in all cases, is exaggerated for curved surfaces. That is the determination of the treated area, which could frequently be in error by 10

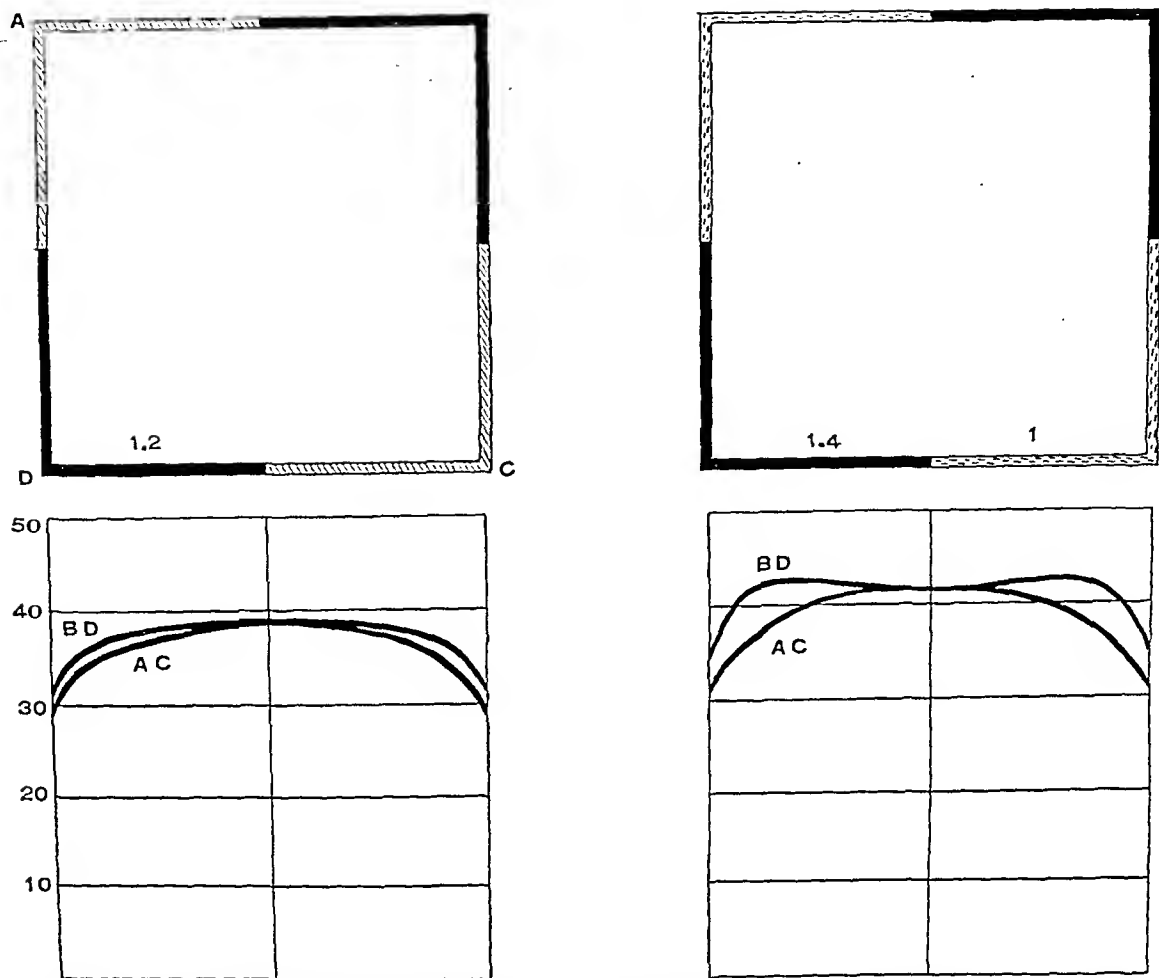


Fig. 3. Radium applicator 3 cm.  $\times$  3 cm. made with 8 radium tubes. On the left side the 4 dark tubes have 1.2 mg./cm. On the right the dark tubes have 1.4 mg./cm. In each case the lightly shaded tubes have 1.0 mg./cm. The variation of dose along the diagonals AC and BD in the treated area is shown below each square.

per cent. This would give a dosage error of 5 per cent. Referring to Figure 1, there is some indecision even in this simple case. The effective treated area lies between that of the hexagon (area 12.6 cm.<sup>2</sup>) and the inscribed circle (11.4 cm.<sup>2</sup>). The corresponding dosage readings from the area charts differ by 5 per cent. In this particular case, one can consider an equivalent circle, which proves to have a radius of 1.98 cm. and an area equal to the hexagon (by coincidence only). If gold seeds were used as the sources, one would invariably operate in terms of the circle through them.

The last error to be discussed is one of the most serious. It relates to the mechanical difficulties in placing the radium tubes at the prescribed distance from the

skin. It is not easy to mount radium tubes on wax or similar applicators so that they be within 0.5 mm. of the correct distance. Customary methods are not accurate to much better than 1 mm. The error has two parts, a systematic deviation from the true thickness plus a random fluctuation. The systematic error is numerically equal to the distance error (approximately). Applicators at 10 mm. give 5 per cent dosage error. Applicators at 10 mm. or less are open to serious objections on these grounds. Where the general thickness is correct and a single tube is misplaced, the error in its vicinity is approximately half that quoted.

When the several errors are marshalled together, it seems probable that there is

more influence on the dosage rate than on the dosage distribution. The latter is influenced mainly by oblique filtration (which can sometimes improve the distribution), faults of loading or placing individual tubes, and the errors of curvature. The former, on the whole, should fall below the theoretical value, because absorption and oblique filtration both tend to reduce it.

Applicators can be divided into two arbitrary classes.

net error, but a variation of  $\pm 15$  per cent with a dosage rate error of 5 to 10 per cent seems probable. Under these conditions it is debatable whether improved arrangements of radium should be developed. The variation could be reduced appreciably with little change in the dosage rate error.

It is always advisable to supplement dosage calculation by direct ionization measurement. It is laborious to check the full distribution, but the readings at

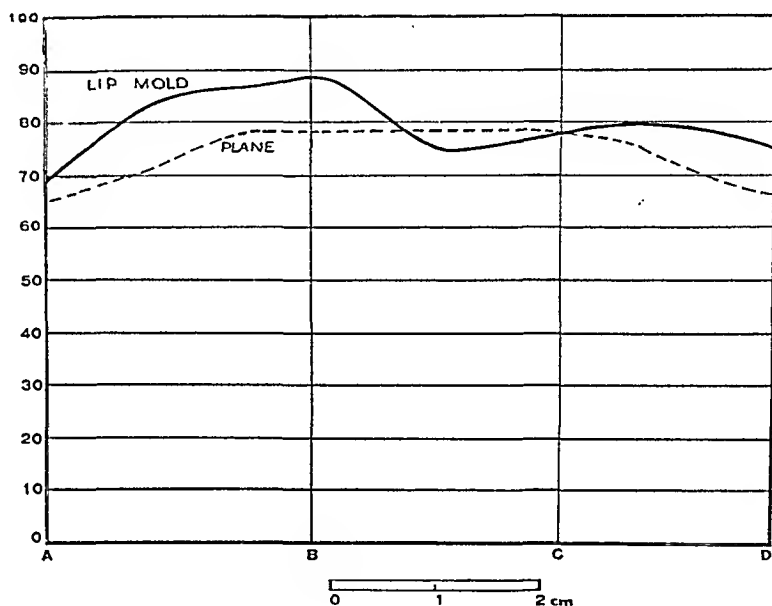
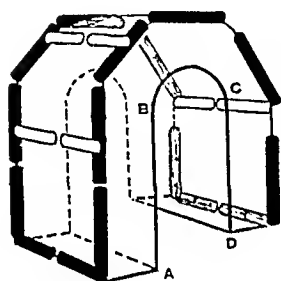


Fig. 4. A conventional lip mold. Shaded tubes have 3 units of radium per cm. Clear tubes have 2 units of radium per cm. The relative dose along a line similar to ABCD, but in the mid-section, is shown in the full curve. The broken curve gives the dose for the equivalent plane, *i.e.*, a plane of length ABCD and width equal to the original. This would be the calculated dose by the Paterson-Parker system. Note that the true dose is high principally over the outer surface of the lower lip A to B, rather than over the actual curved region B to C.

1. *Distance 1.5 cm. or more:* The distribution rules can be closely obeyed and the geometry of the mold kept accurate. Practically all cases can be treated with a theoretical variation of  $\pm 5$  per cent. The subsequent errors are estimated to be of this same order.

2. *Distance less than 1.5 cm.:* The original system may use up the full  $\pm 10$  per cent tolerance. It is more difficult to reproduce a theoretical arrangement with discrete tubes. At the same time oblique filtration and the faults of loading and position have their greatest effect. It is difficult to ascribe numerical limits to the

selected points can remove the principal dosage rate errors. The author has found closer agreement between measured and calculated doses than would be expected on the basis of the foregoing discussion. A deviation of more than  $\pm 3$  per cent has been exceptional. It is believed that this is due to the fact that applicators required in the clinic happen to fall in those parts of the system that are inherently accurate. Applicators at distances less than 7.5 mm. are liable to be faulty both in calculation and measurement. In these cases the finite size of the measuring device may become important (7). Here again, clinical



practice favors the system. Such applicators are needed either for lesions like hemangioma, where the dose is low, or in the buccal cavity, where reaction is not very sensitive to change of dose. In neither case is there danger in the treatment or loss of information of scientific interest.

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#### DISCUSSION

Otto Glasser, Ph.D. (Cleveland, Ohio): This paper obviously adds some valuable information to the Paterson-Parker system or the Paterson-Parker charts, which, as all radiotherapists and physicists interested in radium therapy know, form the foundation for dosage and the study of distribution of radium around various applicators.

I think we are fortunate to have Doctor Parker in this country now and to have the advantage of hearing his excellent paper. We are looking forward to still more studies on his part which will round out the Paterson-Parker system and give to the radium therapists the tools they need to do more accurate work.

Milton Friedman, Major, M.C. (New York, N. Y.): The Paterson-Parker radium dosage system is a contribution probably equal in importance to Coutard's system of external roentgen therapy.

Roentgen radiation all too frequently is incapable of eradicating the residual small component of radio-resistant cells in a tumor. Resultant recurrences are either early (three to six months) or late (two to seven years). Failure to act on this well known fact by employing interstitial radium therapy at the appropriate time is responsible for the increasing use of surgery in lesions which were formerly irradiated.

By means of periodic biopsies taken during roentgen irradiation, it can be determined whether radium should be used early (after ten to fourteen days) or later (one to two months after roentgen therapy has been completed). In the former instance, the radium dose is small and is added to the roentgen dose. In the latter case, radium is given as a separate treatment; the dose must be large, and the radium is placed in an intolerant tumor bed. It is therefore necessary that the distribution be accurate and the chosen dose be correct. This can best be achieved with the aid of the Paterson-Parker radium dosage system.

The system is complicated, difficult to apply, and not yet completely satisfactory. It requires minor adjustments, which experience will provide.

A final point is the problem of oblique filtration, the neglect of which factor is responsible for a number of errors in radium dosage. Because of the oblique filtration of the wall of a radium capsule, the amount of radiation coming off the axial and oblique end of a capsule or tandem pointing at the fundus of a uterus, for example, is very small, much less than is believed. Any attempt to irradiate a carcinoma of the fundus with a single tandem provides inadequately small amounts of radiation to the tumor. Furthermore, the following error is frequently encountered in the uterus: An intra-uterine tandem for a carcinoma of the cervix is constructed by placing several radium capsules inside a rubber tube; a cotton plug is then inserted to fix the radium in position, and the rubber tube is tied with thread. When this applicator is inserted into the uterine canal, the lowest radium tube will often lie just above the cervical canal, which is occupied by the cotton plug, the thread, and the distal empty part of the rubber tube. Furthermore, the oblique filtration of the lowermost radium capsule is such that it may further reduce the amount of radium radiation reaching the cervix.

H. M. Parker, M.Sc. (closing): Doctor Friedman's remarks are quite pertinent, and the problem he presents is a real one. This particular type of treatment was carefully avoided in my discussion. As I said, interstitial treatments are up to the clinician; physics has done all it can and then got out of it while there was yet time.

Surface treatments we can elaborate down to any desired standard. Treatment within the cervix is something that no physicist really likes to play with. One can, however, use supplementary radiation from other foci. I think this is the best that can be done except for the hope that the tubes may be put in so loosely that they wiggle. If they wiggle just a few degrees, the isodose curves around the wiggling tube become almost spherically accurate.

# Some Recent Applications of Nuclear Physics<sup>1</sup>

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THE CONTINUED effort of the physicist to learn something of the fundamental nature of matter has in the past paid richly in its by-products. One could readily recall whole professions or industries, each based upon the discovery of some underlying physical principle. In most cases the original discoverer either lacked the interest or the imagination to carry through the application of his discovery.

wide variety of uses to which the cyclotron and its products may be put.

I would like to remind you of the present state of our knowledge regarding the existence of fundamental particles and the structure of matter. It has become difficult to define a fundamental particle, because within the atomic nucleus the usually recognized elementary particles may be transformed into other particles. In Table

+	NEUTRAL	—	MASS
PROTON J.J.Thomson 1906	NEUTRON J.Chadwick 1932 I.Curie — F.Joliot		$1.66 \cdot 10^{-24}$ gm.
		MESOTRON	$18 \cdot 10^{-26}$ gm.
POSITRON C.Anderson 1932	NEUTRINO (NO DIRECT EVIDENCE) C.D.Ellis Wooster 1927	ELECTRON J.J.Thomson 1897	$9.15 \cdot 10^{-28}$ gm.
	X-RAYS (1895) GAMMA RAYS (1896) (PHOTONS) Planck 1901		1 M.E.V. $1.70 \cdot 10^{-28}$ gm.

TABLE I. FUNDAMENTAL PARTICLES

This has not been the case with the most recent important physical device, namely, the cyclotron. The inventor, Dr. E. O. Lawrence, more than anyone else visualized the tremendous potential importance of the instrument, not only in physics but in all related sciences. Thus inspired, he has devoted every effort to its improvement. The applications discussed in this paper are only representative in a small way of the

I, the known elementary particles are tabulated, together with information relative to their mass, their electric charge, and, where it seems reasonably certain, their discovery. The known elements may be arranged in a series or periodic table according to weight, in which the lightest element, hydrogen, is number one and the heaviest element, uranium, is number ninety-two. Each element is regarded as consisting of a nucleus, which possesses most of the mass of the atom and is positively charged, while outside the nucleus

<sup>1</sup> Presented before the Radiological Society of North America at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

of the normal atom are as many negatively charged electrons as the number of the element in the periodic table. The complete normal atom is electrically neutral and has chemical properties determined by the number of the outer electrons.

The nucleus of the hydrogen atom is called a proton. The nuclei of heavier atoms are regarded as being built up of protons plus neutral particles of approximately the same mass called neutrons. Each proton has a positive charge equivalent to that of an electron, so that the num-

Berkeley, where the cyclotron had been in operation for some time, it was found that the entire tank of the cyclotron was radioactive. Subsequent tests showed that by accelerating deuterons, *i.e.*, the nuclei of heavy hydrogen of mass two, and bombarding other elements, practically every element in the periodic table could be made radioactive. At the present time over 340 radioactive isotopes have been produced and identified. These radioactive elements may emit electrons, positrons, and gamma rays, and have half-lives that vary from a

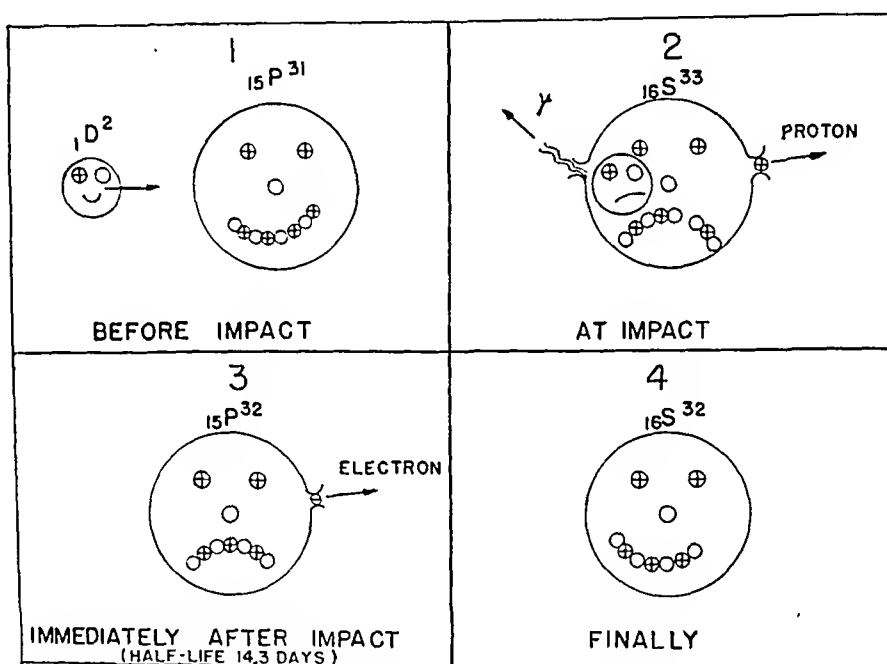


Fig. 1. Life of a radioactive phosphorus nucleus.

ber of protons present determines the charge and hence the atomic number and the chemical properties of the element. Any particular element, *i.e.*, definite electric charge in the nucleus, may exist in a variety of different atomic masses. These various forms are called isotopes and differ among themselves only in the number of neutrons present. There are now in all, 350 known stable isotopes of the ninety-two elements.

In 1934 it was discovered by I. Curie-Joliot and F. Joliot (1) that matter bombarded with energetic particles becomes radioactive. When this news reached

fraction of a second up to many years. For each reaction an equation may be written, but unlike the equations of chemistry the number of atoms of A and B on the left side do not necessarily add to the number on the right. Instead, new atoms, C and D, may appear on the right, and only the total energy before and after is equal.

In Figure 1 is portrayed schematically the life history of an atom of radioactive phosphorus, now used so extensively in medicine. In form 1 the incident deuteron is about to impinge on the phosphorus nucleus of mass 31 and charge 15, written as  ${}^{31}_{15}\text{P}$ . Upward curvature of the features

indicates stability, while a frown denotes internal disorder only to be relieved by the final radioactive spasm in which radiation is ejected. At impact, in form 2, the phosphorus of mass 31 is momentarily transformed to sulfur of mass 33, which immediately emits a proton and gamma ray. This results in a radioactive phosphorus atom of mass 32, shown in form 3, whose half-life is 14.3 days. This radioactive phosphorus emits an electron, called beta radiation, and becomes a normal stable atom of sulfur of mass 32. It is believed that a light, neutral particle called a neutrino is emitted with the beta particle. Thus, from the nucleus, consisting only of a collection of neutrons and protons, other fundamental particles emerge, so that within the nucleus transformations from one particle to another may take place. The proton may yield a positron and a neutron. Conversely a neutron may split into a proton and a negative electron.

In the field of physics recent investigations have advanced substantially our knowledge of the structure of the nucleus. These details, however, are of interest only to the theorist, and I will confine my remarks to the more interesting applications.

It is apparent that by using radioactive or tagged, detectable elements the behavior of matter may be followed in whatever field of science one is interested. To illustrate the scope of this usefulness, only one or two applications will be mentioned from each of several related sciences. This material is not to be regarded as a complete report on each investigation but only to suggest the problem and its solution.

*Astronomy:* Remote as may seem any connection between astronomy and nuclear physics, it is a fact that only now, by information gained in studying nuclear reactions, has it become possible to answer one of the most puzzling questions, namely, the source of the energy sent to us from the sun. The solar constant of radiation at the earth is known to be about two calories per square centimeter per minute. From this one can calculate the total energy radiated

by the sun in any interval of time. If a reasonable value be assumed for the thermal capacity of the sun, then the energy loss due to radiation is sufficient to reduce the temperature about  $15^{\circ}$  C. per year if the sun were simply a cooling body. Actually no drift in the solar temperature can be observed. It must follow that some processes are taking place on the sun so as to release energy as fast as it is being radiated. From the knowledge of nuclear reactions, H. Bethe (2) has been able to show that conditions within the sun are such as to allow the release of atomic energy at this rate. Although the average specific gravity of the sun is about 1, still, at a sufficient depth where the specific gravity is 80 and the temperature is 20 million degrees Centigrade and the content of the sun is 35 per cent hydrogen, nuclear energy is being released at a rate of 100 ergs per gram per second. This is sufficient to account for the total radiation. In this reaction carbon serves as a catalyst for forming helium from hydrogen. The carbon unites cyclically with protons, becoming in turn nitrogen and oxygen. The excited oxygen finally splits into an alpha particle or helium atom and a carbon atom identical with the original. As stars grow older, their hydrogen content diminishes.

One of the most active fields of research at present, involving nuclear reactions, is the study of cosmic radiation. This radiation is the very penetrating shower of energy that continuously impinges on the earth from the outside space, in all directions. Since its discovery, a controversy has persisted regarding the fundamental nature of the primary cosmic radiation. Only during the present year has it been possible to announce, with certainty, that this radiation consists of a rain of protons, some with energies of several billion electron volts. The problem now will be to establish the source of this radiation.

*Botany:* Radioactive salts in solution may be taken up by the roots of plants and a subsequent study made of the circulation of the plant. In this manner F. Gustafson (3), in a single brief experiment, showed



Fig. 2. "Auto-radiograph" showing the distribution of radiophosphorus in the leaf of the tomato plant (Stout).

that the generally accepted notion of the upward transport of dissolved materials had not been completely correct. By cutting away the stem, it was found that these were not carried entirely in the woody part of the stem, as had been supposed, but that the bark also aided in the transport.

Figure 2, due to P. R. Stout (4), illustrates a technic that may be used to show the distribution of a radioactive element throughout the plant. After irradiation, a section of the plant is placed in contact with a photographic plate. The blackening of the plate, which may be termed an "auto-radiograph," is a measure of the abundance of the radioactive element in any particular part. The assimilated phosphorus is seen to accumulate in the conduction system of the leaves and in the seeds of the fruit.

*Chemistry:* Illustrative of the use of

radioactivity in chemistry is a study made on the phenomenon of adsorption. Although several theories regarding adsorption had been proposed, definite experimental proof for any particular one was lacking. Professor K. Fajans and Dr. A. Newton, using radioactive sodium and bromine as tracers, have shown that in the case of eosin and erythrosin dyes the adsorption consists entirely of an exchange between the negative ions of the solution and the negative ions of the adsorbent.

It is perhaps of interest that up to three years ago there were still four missing elements of the periodic table, namely, atomic numbers 43, 61, 85, and 87. All attempts of chemists to isolate and identify these elements had been unsuccessful. By bombarding neighboring elements in the periodic table in the cyclotron it has now been possible to produce by transmutations all four of the missing elements.

*Engineering:* Certain of the radioactive isotopes emit gamma rays that are even more penetrating than the gamma rays of radium. This is true for the yttrium isotope of mass 89, which is a by-product in the making of radiostrontium by the bombardment of strontium with deuterons. It may be used to take photographs through inches of steel, giving a result similar to that with an x-ray tube operated at a potential of about two million volts.

*Metallurgy:* The ability of one metal to diffuse through another or through itself has long been a matter of interest. A technic to study the behavior of the natural radioactive elements in contact with other metals was developed by von Hevesy (5). Since any of the known metals may now be made radioactive, no limitation need be placed upon this investigation. A rather complete study of the diffusion of copper atoms in copper as a function of temperature has been made by Dr. C. L. Raynor (6). His results are shown on the semi-logarithmic plot in Figure 3. That the curve is a straight line when plotted in this way is a direct check on the theory developed for this phenomenon. The diffusion of the metal particles is much like the

vapor pressure of a liquid expressed as a function of the temperature. This is of considerable importance in welding, alloying, and case hardening metals.

*Mineralogy:* It has long been known that the color of crystals can be altered by exposure to ionizing radiation, such as x-rays, cathode rays, and gamma rays. Even more striking is the alteration in color produced by exposure to the deuteron beam of the cyclotron. When one considers that

injecting radioactive phosphorus into cats, after which one leg was stimulated while the other was kept inactive. The animals were then sacrificed and tests made of the radioactivity of various extractions. These tests showed that the phosphorus chemistry generally assumed to occur in the muscle during activation is probably not correct. The results, however, involve too many technical details to enumerate here.

*Zoology:* Investigations on the metab-

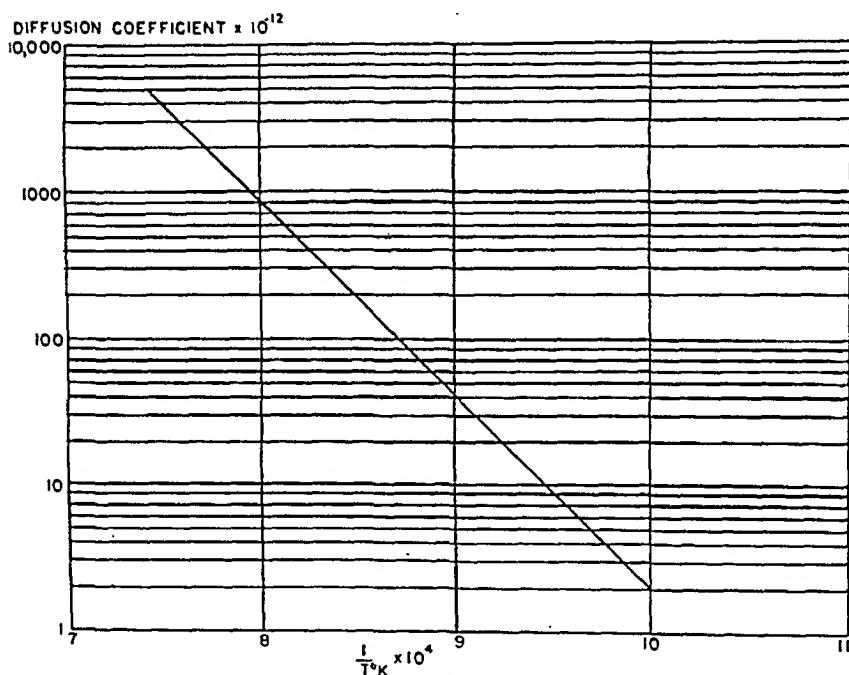


Fig. 3. Self-diffusion of copper.

aquamarine and emerald are chemically identical, yet one has a value a hundred times that of the other, the importance of color is apparent. The most valued diamonds have been the rarely found green crystals. On exposure to deuterons (7) even the most inferior amber tinted diamonds take a permanent green tint equal to that of the best natural green gems.

*Pharmacology:* Making use of radioactive phosphorus, an exhaustive study has been made by Dr. J. Sachs (8) of the chemical reactions associated with muscular activity. This was accomplished by

olism of strontium and calcium carried out by Dr. C. Pecher (9), working at Berkeley, are characteristic of the use of radioactive elements in the field of zoology. Radioactive calcium lactate or strontium lactate was intravenously injected into animals. Forty-eight hours following administration of the radio-element, sections of the animal were made and allowed to activate a photographic plate, giving thereby an "auto-radiograph." It was found that when strontium lactate was administered intravenously, as much as 34 per cent of the dose became fixed in the skeleton. This

very large skeletal uptake, together with the fact that the half-life is 55 days and the radiation consists of beta particles of maximum energy 1.5 million electron volt, makes the substance ideal for selective absorption by and treatment of bone tumors. Figure 4 (from a paper by Dr. J. H. Lawrence, 10), show an "auto-radiograph" of an amputated section of the knee of a patient previously given radioactive strontium. It is apparent that the radioactive strontium has concentrated in the neo-



Fig. 4. "Auto-radiograph" of amputated section of a knee of a patient previously given radioactive strontium (Lawrence).

plastic tissue and in the epiphyseal line where growth is taking place.

*Medicine:* Application of the cyclotron and radioactive atoms in medicine may be classed under three distinct types of use. First, the radioactive atoms may be used as tracers to study physiological processes. Second, neutron radiation (which is emitted copiously when the deuteron beam of the cyclotron is allowed to fall on a beryllium target) may be used in the treatment

of malignant growths exactly as penetrating roentgen radiation is now employed. Third, suitable radioactive elements may be selectively absorbed to treat specific organs. Thus radioactive strontium may be used for bone tumors, radioactive iodine for thyroid disorders, and radiophosphorus for leukemia and polycythemia.

For equivalent ionizing doses, neutron radiation has been found to be from 1.5 to 10 times as powerful as x-rays in its biological effects, depending upon the nature of the subject. This fact alone would not, of course, justify its use. If, however, the differential effect on diseased and normal tissue should prove to be more favorable than that obtained with x-rays, then its importance is apparent. A survey of the present status of the clinical use of neutrons and radioactive phosphorus and radioactive strontium is made in a recent paper by Dr. J. H. Lawrence (10). The ultimate conclusion as to the success of these agents must be deferred.

#### CONCLUSION

Considering that this phase of nuclear physics is less than a decade old, the achievements to date are remarkable. One has every reason to expect that new applications will continue to develop. In the utilization of nuclear energy it is not beyond the realm of possibility that an entirely new era awaits us. It is known that the addition of a single neutron of low energy to the nucleus of the uranium atom may cause it to split into two parts, releasing an energy of about 186 million electron volts. In the fission more neutrons are formed, so that if the process were controlled it might go on spontaneously. The development of this technic is the challenge facing the scientist today, and its importance cannot be over-emphasized. The motive power of this new era might be visualized as being as far in advance of our modern steam turbine as the turbine is superior to the treadmill.

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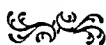
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## DISCUSSION

Henrietta Hayden, Ph.D. (Detroit Mich.): That the pursuit of pure, exact knowledge is a practical process, and in truth is probably the most practically profitable of all human endeavors, is a fact which the scientist is never able to explain to the layman without the greatest difficulty. One reason for this state of affairs is that the pursuit is seldom a source of much material profit to the successful pursuer. Roentgen never became wealthy

and the Curies left no estate, yet billions of dollars of industry and income resulted from their work. Perhaps the best snap answer to the question which is always asked was that of Michael Faraday to Gladstone. When the latter demanded to know of what earthly value Faraday's electric motor could be, Faraday replied, "Some day, my lord, you will be able to tax it." How true this was, Faraday never knew, for he could not anticipate the day when the tax on electric motors alone would be more than the total national income of his age. In a later day the same question was to be asked many times of Steinmetz, but in a far different spirit.

It is encouraging to note that so much has been accomplished in the use of the cyclotron well within the lifetime of its inventor. Professor Cork, whose real contributions have been made in the laboratory, has been too modest to label his own work in this presentation, but he and his associates are responsible for no small part of our profit in these very real and practical advances. We wish to thank him for presenting as one unit the widely diversified applications of the cyclotron from the determination of the structure of atomic nuclei to uses in industry and in medicine.





# Differential Tissue Response to Neutron and Roentgen Radiations<sup>1</sup>

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RADIATIONS DIFFERING in many respects from those hitherto known have become available for investigation following the invention and development of the cyclotron (1). One of these cyclotron products, consisting of high-speed uncharged particles of matter released from the nuclei of beryllium atoms at energies measurable in millions of electron-volts, is of particular interest to radiologists because it shares with roentgen radiation the ability to penetrate matter and to produce ionization. Certain differences in the character of the ionization produced by fast neutrons, chiefly the much more intense concentration of ion-pairs along the path of the ionizing particle, soon led investigators to compare the biological effect produced by x-rays and neutrons. As soon as it was established that the two radiations were identical in qualitative effect, study was directed toward the detection of possible differences in their selective action on various tissues, that important attribute of any radiation which is to be employed therapeutically.

Even though it was impossible at first to produce a collimated neutron beam comparable to the x-ray beams commonly used in clinical radiation therapy, because of structural and capacity limitations of the cyclotrons of early design, Lawrence, Aebersold, Lawrence, Zirkle, and Dempster (2, 3, 4), working within the limitations imposed, were able to demonstrate convincingly that the relative effects of neutrons and x-rays differed for various biological test objects such as living white mice,

*Drosophila* eggs, fern spores, wheat seedlings, and tumor transplants. Proof that such differences exist was significant and timely because it established the possibility that similar differences in the response of normal as compared with neoplastic tissues might later be discovered. Zirkle and Lampe carried this line of investigation one step farther (5) by demonstrating that within the same species of organism (*Drosophila* eggs of various ages) and within the same individual organism (the shoot and the tap root of the wheat seedling) there are obvious differences in the relative effectiveness of neutrons and x-rays in producing comparable biological changes. These experimental results obtained with closely related tissues strongly suggested the existence of a characteristic selective action of neutrons differing from that of x-rays but provided no information as to which form of radiation might be expected to be more efficacious in the clinical treatment of malignant neoplasms.

It is natural, of course, that radiologists should be impatient to learn whether or not they may look upon fast neutron radiation as a promising asset in cancer therapy, and in search of further information on that score experimentation has continued. Continuous improvement in cyclotron design resulted in comparable increases in available neutron output until fast neutrons could be collimated into a beam of dimensions and sharpness similar to the x-ray beams currently employed in x-ray therapy. Now, at last, experiments closely simulating situations encountered in clinical practice could be attempted.

One such experiment, originally employed in 1927 by Ferroux and Regaud (6, 7) to study the differential action of x-rays in living mammalian tissues, is well

<sup>1</sup> From the Department of Roentgenology of the University of Michigan, University Hospital, Ann Arbor, Mich. Presented before the Radiological Society of North America at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

This investigation was supported in part by the Horace H. Rackham Foundation and in part by the National Cancer Institute.

adapted to the comparison of the selectivity with which neutrons and x-rays affect various tissues. Having propounded the question, "Is it possible with a single massive dose of x-rays to sterilize the testis of an adult rabbit without producing serious damage of the serotal skin?", Ferroux and Regaud proceeded to prove to their satisfaction that the answer was "No." They employed x-rays varying in quality from 180 kv.p. to 180 kv. constant potential filtered with 3 to 8 mm. Al, in doses ranging from 3,013 R to 5,565 R administered to the serotal skin and testes of young adult rabbits.<sup>2</sup> Approximately four months after irradiation both tissues were examined microscopically. Preliminary work had indicated that regeneration of the germinal epithelium and the re-establishment of spermatogenesis would be evident at that interval if any of the germinal cells had survived; temporary suspension of spermatogenesis would not be erroneously interpreted. In no single instance were the French workers able to produce lasting aspermatogenesis without seriously damaging the overlying serotal skin. They were able to show, however, that total doses of 4,452 R to 5,000 R of 180 kv. x-rays<sup>2</sup> filtered with 8 mm. of Al administered in two or four equal fractions at intervals of two, three, or six days would enhance the differential effect of this form of radiation to the point of permanently destroying testicular function without seriously damaging the scrotal skin. That fractional irradiation augments the differential or selective effect of x-rays upon neoplastic tissue as compared with normal tissue appears to have been amply proved in the course of clinical experience since the time of these experiments.

Is it possible with a beam of fast neutrons to accomplish the effect which Ferroux and Regaud were unable to achieve with x-rays? If so, it must be clear that, within these experimental limits at least,

neutrons possess to a greater degree than x-rays the ability to affect different tissues in selective fashion. If not, the differential action of these two radiations must be considered equal in so far as these particular tissues are concerned.

On several counts the tissues employed represent excellent test objects. An appendage to the body, the scrotum, together with its contents, is readily accessible for experimentation. Both tissues are in intimate physical association, the testis being surrounded on all sides by serotal skin. It seems improbable that depth dose variations need be considered, since the entire mass measures less than a centimeter in thickness and it has already been shown that the depth dose curves for 200-kv. x-rays and the neutron beam employed are nearly identical (8). Skin, so important in clinical practice in judging radiation effect, in this experiment serves to represent normal tissues in general. The extremely active though controlled cell division which is characteristic of germinal epithelium represents the autonomous growth process of neoplasms more closely than any other normal mammalian tissue. As an end-point for defining the magnitude of the radiation effect, complete and permanent aspermatogenesis can be determined with a considerable degree of precision.

For direct comparison of results, experiments were conducted similar to those of Ferroux and Regaud. The following physical factors were used: 200-kv.p. x-rays (Villard circuit), Thoraeus filter (0.42 mm. tin, 0.25 mm. copper, 1.0 mm. aluminum), 50-cm. skin-target distance, 5-cm. diameter circular field over the testes. Doses ranging from 1,500 r to 2,574 r, as measured in air, were given at one sitting to young adult albino rabbits anesthetized with intravenous sodium amytal. The roentgen output of the apparatus was so adjusted that a minimum of two hours was required for the exposure. This was done in order to approximate the exposure time required for the neutron irradiations. The testes and scrotal skin were removed for micro-

<sup>2</sup> The R referred to here is the French unit in use at the time these experiments were carried out; it is approximately equivalent to one-half of the present r.

scopic examination four months after treatment.

The neutron irradiation of a similar group of animals was carried out by using the collimated beams of two cyclotrons: one in the Department of Physics of the University of Michigan, the other in the Crocker Radiation Laboratory of the University of California. The method of producing a collimated beam of neutrons has been described by Aebersold (8). In order to obtain adequate neutron intensities from the Michigan cyclotron, it was necessary to insert a beryllium probe through the tank wall directly into the deuteron stream within the D electrodes. Because of this, a distance of 15 to 20 cm. existed between the source point of the neutrons and the beginning of the collimator structure. In the Berkeley cyclotron the neutrons originated at the target immediately adjacent to the collimator. Both cyclotrons provided high energy neutrons; each beam contained a small fractional component of gamma rays.

The orifice of the Michigan collimator was approximately 5 cm. in diameter; that of the Berkeley cyclotron  $7 \times 7$  cm. Various investigations revealed that the collimators produced well demarcated beams of neutrons. Under intravenous sodium amytal anesthesia the rabbits were fixed in position so that the genitals were adjacent to the collimator orifice. Doses were measured in *n*, using a Victoreen ionization chamber<sup>3</sup>; the measurements were made in air without back-scatter. The output at the collimator orifice was calibrated against readings of a Geiger counter near the controls of the cyclotron, and the accumulated dose administered to any rabbit was read on the counter. The Victoreen *r*-meter chamber employed at the University of Michigan was calibrated against that used at Berkeley by simultaneous exposure of both chambers to the neutron beam of the California cyclotron.

<sup>3</sup> *n* is an arbitrary unit representing the amount of fast neutron radiation necessary to discharge the Victoreen instrument to the same extent as does 1 *r* of x-rays.

The readings of the Michigan instrument were found to be 1.08 times as large as those of the Berkeley chamber. All doses have been adjusted to conform to readings of the Michigan instrument. To administer at one sitting the doses employed (356 to 800 *n*), two to four hours of continuous exposure were required, depending upon the output of the cyclotron and the magnitude of the dose.

As in the case of the x-ray irradiations, the rabbits were observed for a minimum period of four months. They were then sacrificed and the scrotal skin and testes were removed for microscopic examination.

It is advisable to consider the significance of the actual doses of x-rays and of neutrons administered in these experiments in relation to the problem of the differential action of these radiations. As yet it is not known whether one roentgen of x-rays produces a magnitude of ionization within tissues equal to that of one *n* of neutron radiation. Quantitative comparison of the effects of the two radiations based on equal numerical values of these two units may not be valid. As long as each form of radiation is used to the point of producing complete aspermatogenesis, differences in the associated skin effects can be used as a criterion of tissue selectivity regardless of physical dosage measurements. Absolute values need not be known to solve the problem at hand; quantitative comparison of the doses employed is beside the point.

The results of x-ray irradiations are tabulated in Table I. Table II records the results of the neutron exposures. The status of the scrotal skin at the end of the four-month period of observation is described as either "healed" or "non-healing reaction." The latter refers to evidence of severe radiation damage, almost always consisting of edema, necrosis, and chronic ulcerations of the skin. In some instances, at the end of approximately two months the acute radiation reactions had subsided considerably and appeared to be healing but later became severe again, with the appearance of the changes described. The term "healed" indicates the

TABLE I: EFFECT OF X-RAY IRRADIATION ON SCROTAL SKIN AND TESTIS OF THE RABBIT

Rabbit No.	Aspermato-genesis	Skin	Dose (r)
4x	Incomplete	Healed	1,500
3x	Incomplete	Healed	1,650
1x	Incomplete	Healed	1,800
20x	Incomplete	Healed	1,900
2x	Incomplete	Healed	1,950
17x	Complete	Non-healing reaction	2,050
18x	Incomplete	Healed	2,100
5x	Complete	Non-healing reaction	2,100
6x	Complete	Non-healing reaction	2,250
7x	Complete	Non-healing reaction	2,400
10x	Complete	Non-healing reaction	2,553
9x	Complete	Non-healing reaction	2,574

subsidence of the radiation reaction leaving minimal or no evidence of cutaneous damage. Minimal damage, when present, consisted of epilation, slight dry scaling, and slight atrophy. The microscopic examination of all the irradiated testes was done by Dr. C. V. Weller, Professor of Pathology at the University of Michigan.

In each of the 6 animals in which complete aspermatogenesis was produced by x-ray irradiation (Table I), the damage of the scrotal skin was marked. In each of the 6 instances of incomplete aspermatogenesis, the scrotal skin recovered from the effects of the irradiation. The doses employed were graduated in magnitude by increments no greater than 150 r. The results are in complete agreement with those reported by Ferroux and Regaud in 1927; it is not possible to produce complete aspermatogenesis in the rabbit's testis by the administration of a single massive dose of x-rays of the quality employed in these experiments without producing severe damage of the scrotal skin.

In the neutron experiments, 20 animals were successfully carried through the anesthesia, irradiation, and the four-month post-irradiation period. The doses administered to these rabbits ranged from 356 to 800 n. In Table II, in which experiments are arranged in order of increasing dose, the smallest dose which produced complete aspermatogenesis is seen to be 513 n. The scrotal skin of this rabbit recovered from the effects of the irradiation and is listed as "healed." This relative

TABLE II: EFFECT OF NEUTRON IRRADIATION ON SCROTAL SKIN AND TESTIS OF THE RABBIT

Rabbit No.	Aspermato-genesis	Skin	Dose (n)
1A	Incomplete	Healed	356
3A	Incomplete	Healed	400
2A	Incomplete	Healed	500
27B	Complete	Healed	513
5B	Incomplete	Healed	540
9B	Complete	Healed	540
28B	Complete	Non-healing reaction	540
14B	Complete	Healed	566
15B	Complete	Non-healing reaction	566
2B	Complete	Healed	594
4A	Complete	Healed	600
8A	Incomplete	Healed	600
24B	Complete	Healed	620
25B	Complete	Non-healing reaction	620
8B	Complete	Healed	647
9A	Incomplete	Healed	650
4B	Complete	Non-healing reaction	701
7A	Complete	Non-healing reaction	710
6B	Complete	Non-healing reaction	740
6A	Complete	Non-healing reaction	800

effect upon the scrotal skin and testes of rabbits cannot be produced by single massive doses of x-rays as shown by Ferroux and Regaud and by our experiments. Six additional examples of this type of differential action, complete aspermatogenesis and healed skin, are found in rabbits 9 B (540 n), 14 B (566 n), 2 B (594 n), 4 A (600 n), 24 B (620 n), and 8 B (647 n).

In the remaining 13 animals, incomplete aspermatogenesis was obtained, with complete recovery of the scrotal skin in 6: 1 A (356 n), 3 A (400 n), 2 A (500 n), 5 B (540 n), 8 A (600 n), and 9 A (650 n). In 7 rabbits—28 B (540 n), 15 B (566 n), 25 B (620 n), 4 B (701 n), 7 A (710 n), 6 B (740 n), and 6 A (800 n)—although complete aspermatogenesis was produced, severe damage of the scrotal skin occurred.

Doses of 500 n or less in every instance resulted in incomplete aspermatogenesis and skin healing. With doses of 700 n or more the reaction was that of complete aspermatogenesis and severe cutaneous damage. In the range of 513 to 650 n all three reactions were noted: incomplete aspermatogenesis and healed skin in 3 instances; complete aspermatogenesis and healed skin in 7; complete aspermatogenesis and non-healing skin reaction in 3. The combination of incomplete aspermato-

genesis and non-healing cutaneous reaction never occurred.

Our chief interest lies in the group of seven animals showing complete recovery of the scrotal skin with complete aspermatogenesis of the testis, since this type of combined reaction apparently cannot be produced with single massive doses of x-rays. In these rabbits, the differential action of neutrons is different from that of x-rays; the testicular tissue has been damaged more severely in relation to the skin by the neutron radiation than was the case in the animals subjected to x-radiation. Not only was the selective action of neutrons in this group of animals different from that of x-rays, but the difference is in the direction that should constitute an advantage in clinical application, since the testicular tissue in some respects presents the attributes of a neoplasm.

The group of animals within the range of 513 to 650 n which showed the three types of combined reaction merits attention. Within a dosage increment of 137 n are 7 instances of complete aspermatogenesis with healed skin, 3 of complete aspermatogenesis with non-healing of the skin, and 3 of incomplete aspermatogenesis with healed skin. A more clean-cut type of result would have seen all instances of incomplete aspermatogenesis with healed skin grouped together in the lower range of dosage, a middle group of complete aspermatogenesis with healed skin, and, in the highest dosage range, only instances of complete aspermatogenesis with non-healing reaction of the skin. That this is not the case may be due to inaccuracies in dosage measurement, and to the usual type of variation to be expected in biological experiments. The advantage, however, in selective action which neutrons appear to have over x-rays in damaging testicular tissue in relation to skin effect, may be relatively slight, so that in some cases it may be obscured by the variations to be expected in testicular reaction and in skin reaction.

In the case of Ferroux and Regaud's work, the demonstration of increased

selective action of x-rays upon testicular tissue relative to skin effect with fractional irradiation received subsequent corroboration in the observations of the effect of fractional irradiation in clinical radiotherapy. Will the demonstration of a greater selective action of neutrons upon testicular tissue relative to skin effect also be borne out in clinical practice?

A primary consideration must be certain physical characteristics. Can the difference of the two radiations in their effect upon skin (when equivalent effects on testicular tissues are produced) be due to differences in the spatial distribution of ionization? As far as is known at present, the depth dose of ionization in large phantoms is approximately the same for the two radiations. The question arises, however, as to the possibility of differences in ionization distribution within the first few millimeters of tissue, which might account for the difference in effect on the skin. With the x-ray radiation employed in these experiments electron equilibrium is reached within the skin; with the still shorter range of the neutron-produced recoil particle (as compared to the range of the x-ray electron) it would seem that equilibrium would also be reached within the skin.

It is possible that certain differences in back-scatter phenomena between the two radiations may account for the differences in skin effect and that future additions to the knowledge of the scatter phenomena of neutron radiation may reveal that the differences observed were on a physical basis and were not due to specific differences in biological reaction to equivalent quantities of ionization. As previously suggested, there appears to be some evidence that the difference in the selective actions of the two radiations may be, on the average, slight. In clinical situations numerous factors may exist to obscure such differences. Furthermore, it must be borne in mind that the advantageous selective action of neutrons on testicular tissue has been demonstrated only for single massive doses; the relative differ-

ential effects of the two radiations upon the rabbit's testis and skin under the condition of fractional irradiation is not known.

#### SUMMARY

1. The experiments of Ferroux and Regaud in 1927, which proved that with a single dose of x-rays permanent sterilization of the rabbit's testis could not be produced without severely damaging the serotal skin, have been repeated with results which confirm their conclusion.

2. Testing the relative biological effects of fast neutrons under the same experimental conditions, it has been found that, within a restricted dosage range, this form of radiation exhibits a sufficiently greater degree of tissue selectivity to produce aspermatogenesis in the rabbit without serious skin damage.

3. Although the difference in selective tissue effect between neutrons and x-rays may be slight, as shown in this particular experiment, the direction of that difference seems to indicate that neutron radiation may hold an advantage over roentgen radiation in the treatment of human neoplasms.

4. It is possible that fractionation of dosage may further accentuate the selective tissue effects of neutrons, as is true in the case of x-rays. That possibility has not been investigated with the test objects used in these experiments.

The authors wish to acknowledge with deep gratitude the valuable assistance rendered to them by the entire staff of the Crocker Radiation Laboratory of the University of California, the cyclotron staff of the University of Michigan Physics Department, and by Dr. Carl V. Weller.

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#### DISCUSSION

Robert S. Stone, M.D. (San Francisco, Calif): Doctor Hodges has presented us with some interesting information. His x-ray table, which I have before me, looks too good to be true. The statistical variation comes to an end-point that one does not expect to find in biological material. There is, indeed, only one point of overlapping, and that is around the 2,000 roentgen dose. Doctor Hodges has, of course, supplemented and corroborated work that was done before, reaching the same results. The overlapping in his series is not such as to indicate that one can get complete aspermatogenesis with healing but is simply a reversal of both factors showing non-healing and complete aspermatogenesis with a lower dose in one instance and incomplete spermatogenesis with skin healing following a higher dose in another. I think that, with a larger number of animals, there probably would be more such observations.

When we come to the neutron cases, there is, as one would expect, a great deal of overlapping. Yet the fact is well established that it is possible to get complete aspermatogenesis and healing of the skin. This finding interests me, especially because the more we are doing neutron therapy, the more we are finding difficulty in getting a dose that does not destroy too much normal tissues, and the longer we follow these patients the more we are finding that we have destroyed the skin and subcutaneous tissues in a way that is not customarily seen following x-ray therapy when a skin reaction has been produced which heals satisfactorily in the first instance.

The work that has been going on at the Berkeley laboratory has been much reduced in the last few years—the last year particularly—but there is still some work proceeding. Doctor Marshak has shown that we get a great variation in the factors between neutrons and x-ray depending, apparently, upon the physiological state, as he prefers to call it, of cell activity. One cannot call this the stage of mitosis because it lies in reality between the mitotic divi-

sions. By some it is spoken of as the resting stage; Marshak believes it is the preparatory stage for mitosis. He finds, for instance, that there may be a variation of factors as great as six to one for neutrons to x-ray, up to fifteen to one. It has also been found that in some types of biological reaction the ratio is reversed and the neutrons do not seem to be so valuable as x-rays, or shall I say the utilization of the energy is less satisfactory?

None of these studies, however, has come quite so close to the problem existing in man as this work that Doctor Hodges has done. I am sure that it will stimulate us, when we have the opportunity to go ahead, to see whether a better method of using neutrons in human therapy cannot be found.

Just as Doctor Hodges has found that he could not produce the changes he set out to, so we have found that in man we can kill cancer cells in the treated regions but we cannot yet do it without killing adjacent cells.

**D. W. Kerst, Ph.D.** (Urbana, Ill.): Since the action of neutrons is to produce recoil protons in the hydrogenous material of the flesh, there might be a transition layer, having a thickness of the order of the range of the recoil proton, at the surface where the neutrons enter the tissue. If the neutrons which were used had an energy of about 12 million electron-volts, the recoil proton track could be as much as 1.7 mm. long. This would mean that the ionization produced by the protons would rise to a maximum a short distance below the surface of the skin, and if the scrotum which covers the testicle were of the order of 1.0 mm. in thickness, it would be expected that the reaction in the scrotum would be less than the reaction in the testicle. This certainly would be true at the entrance surface of the biological specimen.

Such a transition layer could be avoided by surrounding the specimen with hydrogen-containing material so that the dose in the scrotum would be about the same as the dose in the testicle. Such a rise in ionization below the entrance surface is analogous to the rise which occurs with x-rays of several million volts. Do you know whether or not there is a rise in ionization under a surface bombarded by neutrons?

**Helen B. Flynn, M.D.** (Chicago, Ill.): Has Doctor Hodges conducted any experiments in regard to the sterilization of various types of bacteria not enclosed in cellular bodies?

**Fred J. Hodges, M.D.:** Doctor Stone has suggested that the transition from one type of response to another in the x-ray series is too abrupt and too good to be true. It is quite true that the number of experiments conducted using the x-ray beam was

not great, because we already had an indicator in the work of Ferroux and Regaud as to just about what the critical point should be. I, too, was surprised and I agree that if the number of experiments had been greater there might have been more overlap than was shown.

I think it is also entirely understandable that with the neutron technic there was considerably more overlap, since the opportunities for irregularities in exact dosage were certainly greater.

As to the matter of equilibrium developed in the skin which has been mentioned, I do not feel qualified to answer a physical question of that sort. I am familiar with blanketing methods, the use of paraffin or some other hydrogen-containing substance over the surface in order to produce equilibrium at the surface. The biological material in this case is not over a centimeter in thickness because it is held away from the rabbit and in the beam while all other parts of the animal are shielded. Under these conditions the variation in depth dosage when x-rays were used certainly could not have been very important.

I do not know about the production of more intense radiation in the first few millimeters of surface skin, I shall not even attempt to answer that question because I am not qualified.

As to the lethal effects on bacteria existing *in vitro*, so to speak, or culture media, I have no firsthand knowledge whatever.

**Doctor Stone:** I doubt that there would be very much depth necessary with the quality of radiation given to build up a saturation of electrons. Possibly Doctor Quimby could answer that question. But even when we know the answer, I doubt that we know much about the saturation on the surface from neutron radiation.

**Edith H. Quimby, Sc.D.** (New York, N. Y.): As far as x-radiation is concerned there isn't any depth of tissue necessary at all for 200-kilovolt radiation. Electron equilibrium is established for this voltage in a very small fraction of a millimeter. I think what Doctor Kerst was bringing out was that in the case of neutron radiation it is necessary to have a depth of tissue in order to produce the same situation and that we should, therefore, in the case of neutrons, put something ahead of the tissue to build up that equilibrium.

The other method which he mentioned is to use a million or a million and a half volt x-ray, in which we don't get our build-up until the depth of a millimeter or so, as in the case of the neutron beam.

**Doctor Stone:** If we don't have a build-up at the surface from the neutron we certainly get a grand reaction from it in spite of this.



# The X-Ray in Curable Heart Disease<sup>1</sup>

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## PROLEGOMENA

HEART DISEASE is too often regarded as incurable or irreversible and no attempt is made to determine its etiology. There are, however, several groups of cases where the heart disease can definitely be considered as curable or reversible. In the economy of medicine it is of little value to the patient or to the community to spend time and money in determining the etiology or source of an incurable disease. On the other hand, it may be of inestimable value if the etiological factor of a curable disease is discovered and removed, or subsequent and similar ills are prevented.

There are several groups of cases included in the general category of heart disease in which the etiological factor *can* be removed or prevented from working, and in these cases the cardiovascular changes may truly be considered as curable or reversible. In view of this fact it is important to consider the possibility of discovering these particular forms of heart disease, the methods by which they may be identified or isolated from the more chronic forms, and the probability of cure if the cases fall into certain groups. The first hint or lead which suggests that a particular patient has a reversible heart lesion may come from any one of a number of sources. It is often evident to the trained eye at the bedside. It may come from a routine laboratory procedure, such as a blood count or a Wassermann test. It may come from the patient himself or from one of the special tests, such as x-ray examination, which is being used more often and more widely, frequently in the hope

that a curable condition can be uncovered.

This paper stresses the value of close clinical co-operation between the roentgenologist and the physician in six types of curable heart disease, three of which can be relieved by surgery (heart disease due to hyperthyroidism, patency of the ductus arteriosus, and chronic constrictive pericarditis) and three in which health can be restored by medical means (beriberi heart disease, acute nephritis and anemia, and gummatous myocarditis).

The emphasis is properly placed on making the correct diagnosis, as only then can the correct treatment be instituted. The only justification for the time spent in making a more accurate diagnosis is the possibility that, in so doing, more help can be rendered to the patient, or that he can more quickly or more certainly be restored to health. I have omitted the technical problems of therapy, no less important, but references are appended to publications in which full details are given as to methods of treatment.

With these introductory remarks (the "prolegomena" of Huxley), let us consider some of the more common and more important forms of curable heart disease. Most of what follows is borrowed from my colleagues, while I am contributing only the roentgenological observations. Team work is an essential in the refinements of medicine and surgery and I express my appreciation to Dr. S. A. Levine, Dr. Robert E. Gross, Dr. Sidney Burwell, Dr. E. C. Eppinger, Dr. Elliott C. Cutler, the late Dr. Soma Weiss, Dr. Marshall Fulton, and many others from whom I have learned so much, some of whose observations and results are incorporated in this paper.

## SURGICAL GROUP

*Heart Disease Due to Hyperthyroidism:*  
Hyperthyroidism may be "masked" by

<sup>1</sup> From the Department of Roentgenology, Peter Bent Brigham Hospital, Boston, Mass.

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symptoms which are primarily those of heart disease. The heart may be normal structurally but overburdened physiologically by the hyperthyroidism, or there may be an underlying structural defect with a lowered work threshold, and the added burden of hyperthyroidism may precipitate heart failure or anginal attacks.

Aside from the cardinal signs of nervousness, palpitation, tremor, exophthalmos, and palpable thyroid enlargement, the important tell-tale symptoms to look for are:

1. Transient auricular fibrillation.
2. Undue loss of weight, in spite of a good appetite.
3. Diarrhea, or undue looseness of bowels.
4. Excessive perspiration.
5. Transient glycosuria.

It is easy to say: "Look for these things," but it is much easier to overlook them or to pay no attention to them when they are present. It is a truism worth repeating that we see only what we look for, but as a rule we must have some hint or lead as to what we should seek. The corollary, therefore, is that we see only what we know. Any of these five features should suggest the possibility of an underlying hyperthyroidism to the alert clinician, even in the absence of the five cardinal signs noted above.

If the physician is *not* alert, the patient may be, and this is one of the most important leads. These hyperthyroid patients seem disproportionately alert in view of the degree of heart failure which is often present. They answer quickly, respond to requests more promptly than other ill patients, their movements are more sudden and abrupt than expected, and their eyes are apt to be bright and slightly staring. The roentgenologist (who after all is a clinician with a peculiar consulting practice) may be the one to give the referring physician the first clue, as this alertness and quickness of response are evident even in the fluoroscopic room.

Another bit of evidence is the warmth

and velvety softness of the skin which these patients exhibit. Working in the dark as much as he does, the sense of touch, as well as vision, becomes an asset to the clinical roentgenologist—only, of course, if he sees the patient as well as his films. But the most striking feature of all to the roentgenologist is the activity of the heart under the fluoroscope. Not only is it apt to be rapid, but it also has a vigorous, snappy, hyperactive beat, in many cases just the reverse of what would be expected with a given degree of heart failure or anginal pain. This hyperactivity may be evident to the referring physician by means of a snapping first sound, or as a hyperdynamic apical pulsation, often suggesting an apical thrill. Such hyperactivity observable fluoroscopically may also occur in other conditions, such as beriberi heart disease, severe anemia, pneumothorax, arteriovenous fistula, patent ductus arteriosus, and in neurocirculatory asthenia. In the last of these conditions the amount of vagal slowing after holding a deep breath is exaggerated, while with hyperthyroidism even the normal vagal slowing is apt to be absent. Similarly, in pneumothorax the exaggerated amplitude of the heart beat is considerably diminished as well as slowed by having the patient take a deep breath and hold it—the well known Valsalva experiment. Furthermore, the exaggerated beat is present only on the side of the heart where the pneumothorax is present, presumably a mechanical effect from the changed intrathoracic pressure, as it gradually disappears if the pneumothorax is prolonged.

If any of these signs leads to a study of the basal metabolism and that is found to be definitely elevated, and remains so on rechecking, the course is clear—thyroidectomy. If the basal metabolism is only moderately elevated or the result is doubtful, a therapeutic trial of Lugol's solution will often decide the question. In the hyperthyroid patient there will be not only a lowering of the basal metabolic rate but also a slowing of the heart rate, a decrease in the hyperactivity of the heart,

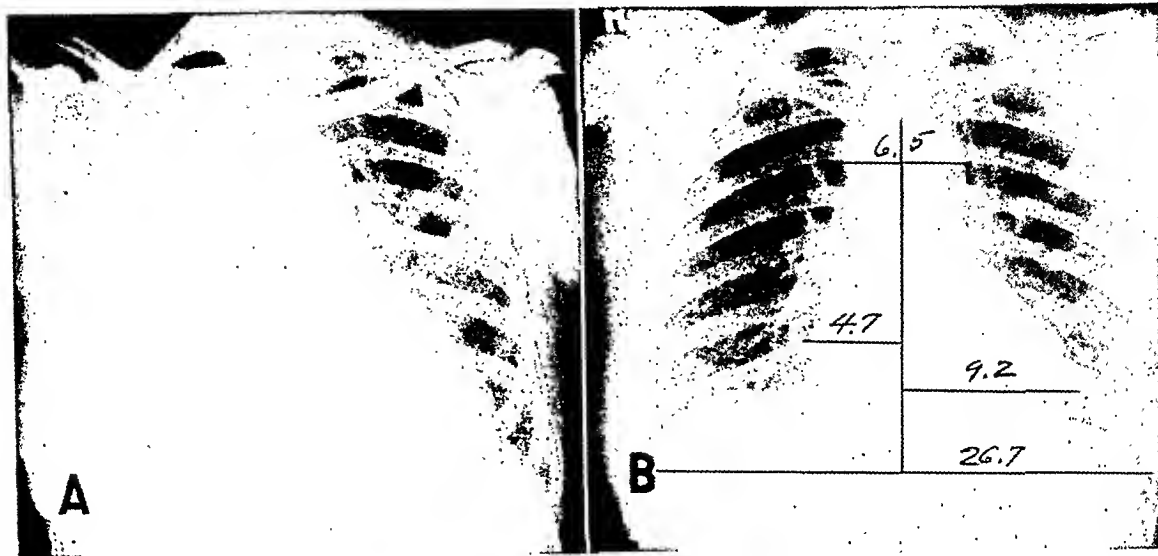


Fig. 1. Case 1. A. Right hydrothorax due to heart failure from masked hyperthyroidism (Dec. 20, 1940). B. Same patient after subtotal thyroidectomy (April 22, 1941).

**Case History:** H. W., white, married female of 34 years, complained of tiredness, weakness, and shortness of breath of six months' duration. "Heart murmur" known for ten years. Twenty-five pounds loss of weight in one year, in spite of "real good appetite." The patient could lie flat without dyspnea. No history of rheumatic fever.

Heart rate grossly irregular, 70 to 120; systolic murmur grade 3 at apex; no diastolic murmur. Blood pressure 130/60. Right chest flat; shifting dullness in abdomen. Liver 5 finger breadths below c.m. No tremor; no exophthalmos; no palpable thyroid enlargement; no nervousness. Slow lid lag. Hands warm and pink; patient subjectively feels warm. Circulation time 14 seconds. Venous pressure 165 mm. H<sub>2</sub>O. EKG showed right axis deviation. Urine negative. Red cell count 3,900,000; hgb. 13 gm.; white cells, 5,450. Cholesterol 170 gm. Total protein 6 gm. per cent. Albumin 2.3 gm. Globulin 3.7 gm. Vital capacity 500 c.c. P.S.P. 43 per cent in two hours.

Fluoroscopy the day after admission showed a hyperactive heart, compatible with hyperthyroidism. Basal metabolism +47, falling after Lugol's solution to +18; after subtotal thyroidectomy to +7, with "extraordinary clinical improvement."

Quinidine given after operation restored the heart to normal rhythm. Vital capacity rose from 500 to 1,100 c.c. Venous pressure fell to 50 mm. H<sub>2</sub>O.

Postoperative fluoroscopy showed the heart slightly enlarged, with slight dilatation of the left auricle posteriorly, but the hyperactivity had disappeared.

We are still uncertain whether or not this patient had a pre-existing mitral stenosis before the hyperthyroidism caused heart failure. She has been well and pursuing normal activities since discharge.

and frequently a marked clinical improvement, often with a striking diuresis if there is edema. (Fig. 1.)

Heart disease due to hyperthyroidism is, as Levine (10) says, "the most important aspect of all heart disease, for it comprises the one large group of cases in which the difference between accurate and inaccurate diagnosis and treatment is the difference between chronic invalidism or death and restoration of health and life."

The opposite or reverse condition of abnormal thyroid function seen in myxedema also may be responsible for heart failure. One of the striking signs in this condition is the marked hypoactivity of the heart as seen fluoroscopically. The heart is usually considerably enlarged, rather triangular in shape, like a medium-

sized pericardial effusion, while the heart beat is indistinct and of small amplitude. Striking decreases in size, increases in visible activity and in amplitude of pulsation, as well as improvement in the lung fields are promptly seen after adequate treatment with thyroid extract.

**Patent Ductus Arteriosus:** A second condition presenting striking hyperactivity of the heart, also curable by surgery, is patency of the ductus arteriosus. Successful ligation of the patent ductus was first accomplished by Dr. Robert E. Gross at the Children's Hospital in Boston, on Aug. 26, 1938, chiefly at the urging of Dr. John Hubbard, the pediatrician. He had noted that while some patients with patent ductus lived without apparent handicap through a normal life, the majority suc-

cardiac embarrassment, and is also amenable to surgical attack, is constrictive pericarditis. Dr. Claude Beck (1) of Cleveland, has pioneered in this field and has contributed largely to its recognition as well as its treatment. My excuse for considering it here is that, as in the previous conditions, the first hint or lead as to the cause of heart failure may come from the alert roentgenologist.

In striking contrast to the two conditions already discussed, the heart in constrictive pericarditis shows diminished or absent pulsations under the fluoroscope. This is one of the most important findings in this group of patients. There may be marked evidence of peripheral congestion and ascites, but on x-ray examination the heart is usually enlarged only slightly, if at all, and the visible cardiac pulsations are greatly diminished or even absent. The heart in chronic pericardial constriction may also be roughly triangular in form with blurring or absence of the normal curves, often less distinct in outline than usual, and it may be difficult to see an actual heart beat anywhere on its contour. In normal or non-constricted hearts it is easy to recognize the auriculo-ventricular junction on the left contour by the difference in time of auricular and ventricular beats. The normal appearance is that of a quick see-saw motion, and the a-v junction is at the fulcrum or balance point of the see-saw. This distinction between auricle and ventricle is usually lost in pericardial effusion, as well as in chronic constricting pericarditis. In the latter condition there may also be an abnormal jerk or tug on the left diaphragm with systole.

In many of my cases of chronic *adhesive* pericarditis, definite plaques of calcification were fluoroscopically demonstrable, at times quite extensive and occasionally dancing with systole like a calcified heart valve. By rotating the patient to both sides it can be shown in one position or another that the calcification is on the surface of the heart and not in its interior. It must be remembered that many cases

of chronic adhesive pericarditis do not present the syndrome of cardiac constriction, even though there may be extensive calcification in the pericardium. The most common places for calcification to occur are in the a-v sulcus, where it may form a complete circle or ring around the heart, and on the diaphragmatic surface of the pericardium, in contact with the right ventricle. I have occasionally seen large defects or windows in the calcified pericardium, through which the heart would protrude with each systole, giving the false suggestion of a ventricular aneurysm. This is most often seen over the apex of the left ventricle, where calcification is less prone to occur, probably due to the constant and marked excursions of the heart in this area. We have also seen calcified infarcts of the ventricular wall simulating localized deposits in the pericardium. (Fig. 3.)

As mentioned above, the striking contrast between marked right ventricular failure and the small or slightly enlarged quiet heart is one of the outstanding features of this disease. Another important feature is the lack of pulmonary embarrassment and the absence of pulmonary congestion on x-ray examination. A third important feature is the constant tachycardia and the small, often paradoxical pulse at the wrist. The heart sounds may be faint or distant, there are no murmurs to be heard, the visible or palpable apex beat may be weak or absent, and the liver is grossly enlarged, usually with ascites. Probably the most important feature of all in making the diagnosis clinically is the elevation of the peripheral venous pressure. The comprehensive studies reported by Blalock and Burwell (3) stress the value of this finding and of the more intricate but very important changes in circulation time and stroke volume.

The clinical signs and symptoms of constrictive pericarditis may be similar to and simulated by tricuspid stenosis, cirrhosis of the liver, rapidly accumulating pericardial effusion (tamponade), cor pulmonale, and occasionally mediastinal tumor. This is not the place to dilate

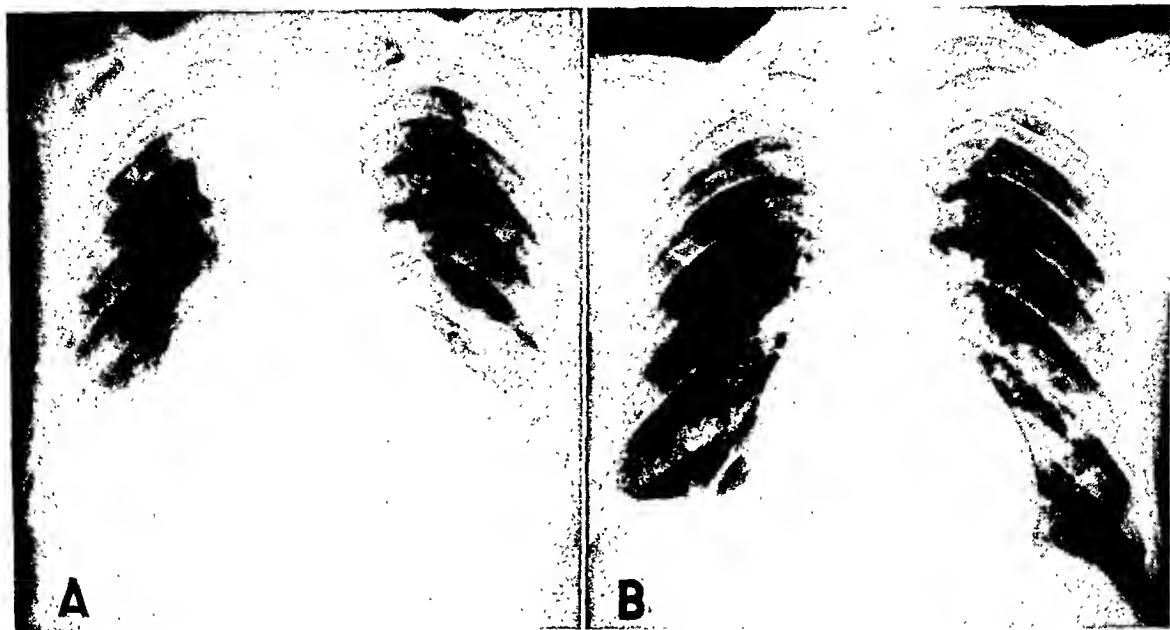


Fig. 3. Case 3. A. Chronic bilateral tuberculous pleurisy and tuberculous pericarditis (Nov. 14, 1932). The oval paratracheal shadow just below the right clavicle is a pocketed effusion in the mediastinal pleural space. Fluoroscopically the visible pulsations were normal in amplitude all over the left ventricle but greatly diminished on the right border and absent over the right ventricle anteriorly. No diaphragmatic tug, no pericardial or intracardiac calcification. Limited descent of heart with inspiration.

B. Seven months after pericardiectomy, heart appreciably smaller, more distinct in outline, lungs clearer, pleurisy quiescent (Sept. 30, 1938). Fluoroscopically pulsations were normal over left ventricle, improved but still less than normal over right ventricle.

*Case History:* G. M., white male, age 37, was admitted Feb. 7, 1938, complaining of gradually increasing weakness, disability, and shortness of breath since an attack of pleurisy six years before.

Physical examination showed slight cyanosis; distended veins in scalp, neck, arms, and abdomen; venous pressure 148 mm. H<sub>2</sub>O; fingers clubbed and cyanotic. Blood pressure 120/90, with a paradoxical swing during respiration. Heart not enlarged to percussion; no murmurs; systolic retraction of precordium. Urine negative. P.S.P. 98 per cent in 2 hours. White cell count 6,700. Liver palpable. Hands and feet cold.

At operation, Feb. 10, 1938, by Dr. Elliott Cutler, the very thick pericardium was dissected away from the anterior surface of the right ventricle (left ventricle appeared normal). Caseous material was found in some areas. Pulsations of right ventricle more normal after operation. Venous pressure dropped from 148 to 55 mm. H<sub>2</sub>O postoperatively. Blood volume, elevated before operation, was normal afterward. Seven months after operation the patient was definitely improved and again able to work. His pulse was 72, venous pressure 130 mm. H<sub>2</sub>O, blood pressure 114/80, with an 8-mm. swing during respiration.

The patient was readmitted in January 1939 for excision of a tuberculous lesion of the right greater trochanter, but has otherwise been working regularly up to the present.

on the differential diagnosis, but I can emphasize the fact that careful examination of the patient by x-ray, particularly by fluoroscopy, is one of the important means of making the differential diagnosis. I must also omit the details of operation, one of the first in America having been done in our hospital by my colleague, Elliott Cutler, in November 1932 (4), and the marked improvement and often cure which may ensue. Fifty-two per cent of the patients in the series reported by Heuer and Stewart (9) were either cured or greatly improved after pericardiectomy, but at the cost of a 33 per cent mortality. With our present knowledge

and technic this latter figure can probably be lowered considerably.

#### MEDICAL GROUP

*Beriberi Heart Disease:* The late Soma Weiss conclusively proved that heart disease due to vitamin B deficiency is present in Boston (11, 12), chiefly in patients who are chronic alcoholics. It has been shown by Bean, Spies, and Blankenhorn (2) and others that there is no essential difference in the alcoholic and non-alcoholic types of beriberi and pellagra. Weiss also demonstrated that the cardiovascular disturbances in vitamin B deficiency do not form a single rigid clinical

syndrome. There may either be failure of the right heart or left-sided heart failure; and the disease may be either "wet", with marked edema, or "dry," without edema.

The essential clinical feature is the occurrence of the disease almost exclusively (in New England) in chronic alcoholics, chiefly those who drink whiskey or gin to excess, who at the same time are well nourished, often fat, and may show the other signs of vitamin B deficiency, such as glossitis, peripheral neuritis, diarrhea (less often constipation), dermatitis, psychosis, and anemia.

The cardiovascular abnormalities are:

1. Tachycardia (particularly in those patients with peripheral neuritis; believed to be due to vagal injury).
2. Palpitation and fatigability.
3. Dyspnea on exertion.
4. A gallop rhythm with increased palpable pulsations, often with a pistol-shot sound in the femoral arteries.
5. Systolic murmurs are frequent, diastolic murmurs rare, both disappearing promptly as the patient improves.
6. A rapid circulation time causing warmth of the extremities, which in ordinary heart failure are cold.
7. A hyperactive heart similar to that in hyperthyroidism.
8. Abnormalities in the electrocardiographic tracings in nearly all cases.

The electrocardiographic abnormalities are not typical or characteristic. The diagnosis is really confirmed by the prompt and striking improvement which follows the administration of massive doses of thiamine hydrochloride, though in some cases the symptoms are made worse in the first twenty-four to forty-eight hours. The first sign of improvement is a slowing of the circulation and a consequent increased utilization of oxygen in the capillaries. Next there occurs symptomatic improvement, often with considerable

diuresis and loss of weight. The vital capacity improves if there has been pulmonary congestion; there may be a striking decrease in heart size, particularly in the edematous cases; but the EKG changes are the slowest to disappear.

X-ray examination may show a hyperactive heart beat similar to that noted previously in hyperthyroidism and patent ductus arteriosus. If there is much edema present, there may also be pericardial fluid which masks the heart beat. In all cases where the pulsations of the cardiac chambers are being studied fluoroscopically, it is important to compare the amplitude of right and left side, in both the postero-anterior and the oblique positions. If pericardial effusion is suspected, it is important also to compare the pulsation of the left ventricle with that of the aorta. An effusion may mask the hyperactivity of the ventricles, but the expansion and collapse of the aorta may be definitely increased in amplitude.

Contributions by x-ray examination are not important in this disease, except as noted above. My chief interest has been in the rapid disappearance of the pulmonary edema; the striking and unusually prompt decrease in heart size, and the change from what seemed to be a badly decompensated valvular heart disease to a normal heart with no audible murmurs, all following injections of thiamine hydrochloride and without digitalis. The wet beriberi changes and improves rapidly; in the dry type improvement is slower and less dramatic. (Fig. 4).

*Nephritis and Anemia:* Striking changes in the size and shape of the heart may also occur in acute nephritis and severe anemia. The cardiac enlargement seen in acute nephritis may be due to hydropericardium or acute dilatation, or both, while that in anemia is presumably due to dilatation. In the latter case the heart will again show a marked hyperactivity of the myocardial beat, corresponding to the palpitation which the patient feels and the systolic shock and rapid pulse which the physician feels. If the hemoglobin is down to 20

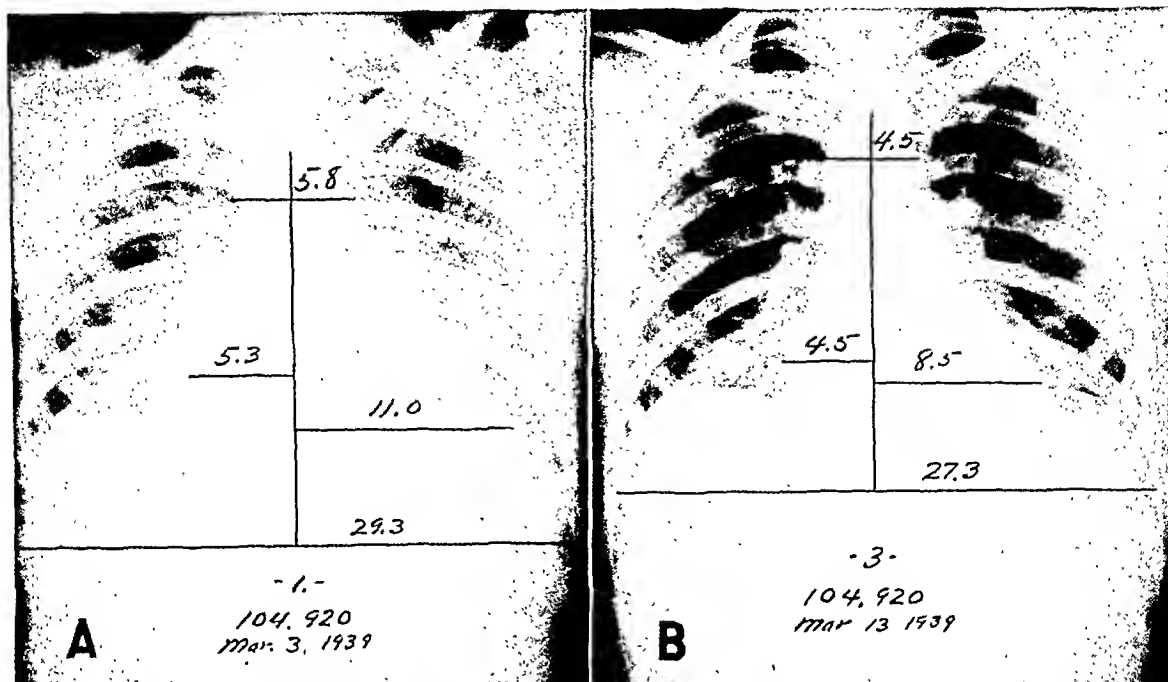


Fig. 4. Case 4. A. Beriberi heart disease with heart failure, pulmonary edema, and pulmonary congestion (March 3, 1939). Heart is enlarged, triangular in shape, indistinct in outline. Fluoroscopy showed very small barely visible pulsations.

B. Same patient ten days later (March 13, 1939), after high-caloric, high-vitamin diet plus 12 mg. thiamine hydrochloride subcutaneously daily and brewer's yeast 4 gm. thrice daily. No digitalis or diuretics administered. Heart has decreased considerably in size, is more normal in contour, more distinct in outline, with marked clearing of the lungs. Fluoroscopically the ventricular pulsations were of normal amplitude.

**Case History:** R. J., white male taxi driver, age 23. Chief complaint: weakness and loss of power in legs. Patient had been drinking one half-pint of whiskey a day for six years and recently had increased to one pint each morning before going to sleep after the night shift. His diet was seriously deficient, consisting chiefly of one cup of coffee at 4 P.M., 2 sandwiches at midnight, and whiskey as noted. Two months before admission he gave up his job, began to drink more and to eat less. Five days previously he became irritable, jumpy, and nervous, and was admitted to a neighboring hospital in delirium tremens. He was sent to us for treatment of heart failure and edema.

Temperature 97.2°. Pulse 104. Respirations 24. Blood pressure 124/62. Patient hyperactive, irritable, and nervous. Heart enlarged to left on percussion; presystolic gallop at apex; grade 2 high-pitched, blowing systolic murmur at apex and soft systolic murmur at aortic arch. Lungs clear to auscultation (*sic*). Liver enlarged and tender. Edema of abdominal wall, sacrum, legs, and ankles. Muscular weakness and paresthesias in arms and legs; diminished reflexes. Basal metabolic rate +23, falling to +9. Cardiac output, March 4, of 9.8 liters per minute, falling to 4.3 by March 15. Circulation time 13.8 seconds March 4, rising to 16.0 seconds March 15 (deeholin method). Urine negative. Red blood cells 3,740,000; hgb. 72 per cent; non-protein nitrogen 57 mg. per 100 c.c. March 4, falling to 27 mg. March 15. Total protein rose from 5.7 to 6.8 gm. Vital capacity rose from 2,000 c.c. to 3,700 c.c. Venous pressure fell from 260 mm. H<sub>2</sub>O to 123 mm. H<sub>2</sub>O. EKG normal. Lead IV also normal throughout.

per cent or lower, there will almost invariably be cardiovascular symptoms with failure. With a subsidence of the acute nephritis under careful treatment, or an improvement in the anemia with proper therapy, the heart will decrease in size and may eventually return completely to normal size, shape, and activity. Such a case is illustrated in Figure 5.

H. A., a 33-year-old woman, formerly a nurse, now a physician's wife, began the dramatic course of a severe acute nephritis with an ordinary sore throat. In a few days, in spite of sulfanilamide, this

progressed to a purulent sinusitis. The patient was admitted to her community hospital on Oct. 1, 1939, because of fever and weakness. On admission the urine was clear and normal; the blood urea nitrogen was 27 mg. per 100 c.c. On Oct. 6 the urine suddenly became bloody and examination revealed albumin, red cells, and casts. The patient was admitted to our hospital Oct. 29, 1939. It was doubtful for a time whether she had subacute bacterial endocarditis with embolic manifestations in the kidneys or an acute nephritis. The course of the disease, however, proved the latter diagnosis to be correct.

During the stay in the hospital, she had a severe anemia (red cells 1,450,000, Hgb. 33 per cent, Nov.

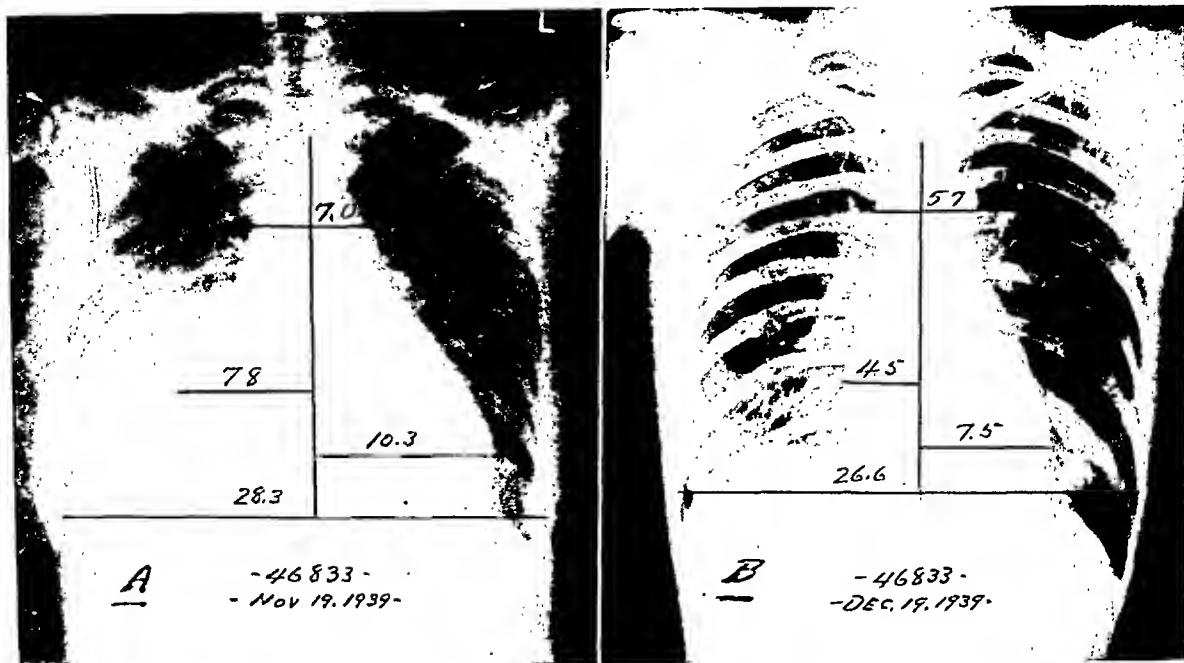


Fig. 5. Case 5. A. Marked change in size of heart, with acute nephritis and anemia. B. One month later, after treatment with diuretics, liver extracts, and transfusions. See text for case history.

Fluoroscopy would have helped differentiate between hydropericardium and acute dilatation. In the former the amplitude of pulsation would have been very small or not demonstrable. In the latter the pulsations would have been distinct and the A-V differentiation definite.

16), a definite hypertension (the blood pressure rose from 112/86 to 180/100), edema of the lower abdomen, sacrum, and legs, and a hypoproteinemia during a prolonged spell of anorexia, nausea and vomiting lasting three weeks, in which very little food could be retained. Her heart became enlarged (Fig. 5A) and auscultation revealed a gallop rhythm, a grade 2 apical systolic murmur, and a peculiar scratchy sound along the left sternal border, which came and went during the several weeks of her illness, presumably a pericardial friction rub. Her pulse became rapid and there were intermittent and temporary attacks of tachycardia. EKG tracings showed partial auriculoventricular block. The blood urea nitrogen rose to 57 mg. per 100 c. c.

The outlook indeed was grave, but with the careful use of digitalis, of repeated small transfusions of citrated whole blood, of vitamin concentrate during the period of vomiting, and of liver extract injections for the anemia, the clinical picture was slowly reversed to its original normal. The abnormal heart sounds ceased. The anemia disappeared, the blood pressure fell to normal, the hypoproteinemia disappeared, and the renal function improved markedly. The heart returned to normal size and contour (Fig. 5B).

We are still speculating as to the cause of the marked cardiac enlargement in this case. Was it an acute dilatation or a hydropericardium or both? Was it due

to the hypertension, to the anemia, to the hypoproteinemia, or just a part of the general anasarca? Whatever its cause, the restoration was prompt and complete, and the patient has remained well to date.

One vital factor in the cure of this seriously ill patient and in the reversal of the cardiac condition was the use of repeated small transfusions. In ordinary heart failure, transfusions are more apt to be harmful than beneficial, and bleeding is a more valuable form of treatment. In this patient, in spite of the edema, the hypertension, and the enlarged heart, transfusions were given because of the anemia and the hypoproteinemia, and were followed by a striking diuresis and clinical improvement. There is a bare possibility that vitamin B deficiency played a part in causing the cardiac enlargement and that the vitamin concentrates aided in the diuresis, as in beriberi heart disease.

Whatever the cause, this patient illustrates the principle of a reversible heart disease due to factors outside the heart. There are numerous other conditions illus-



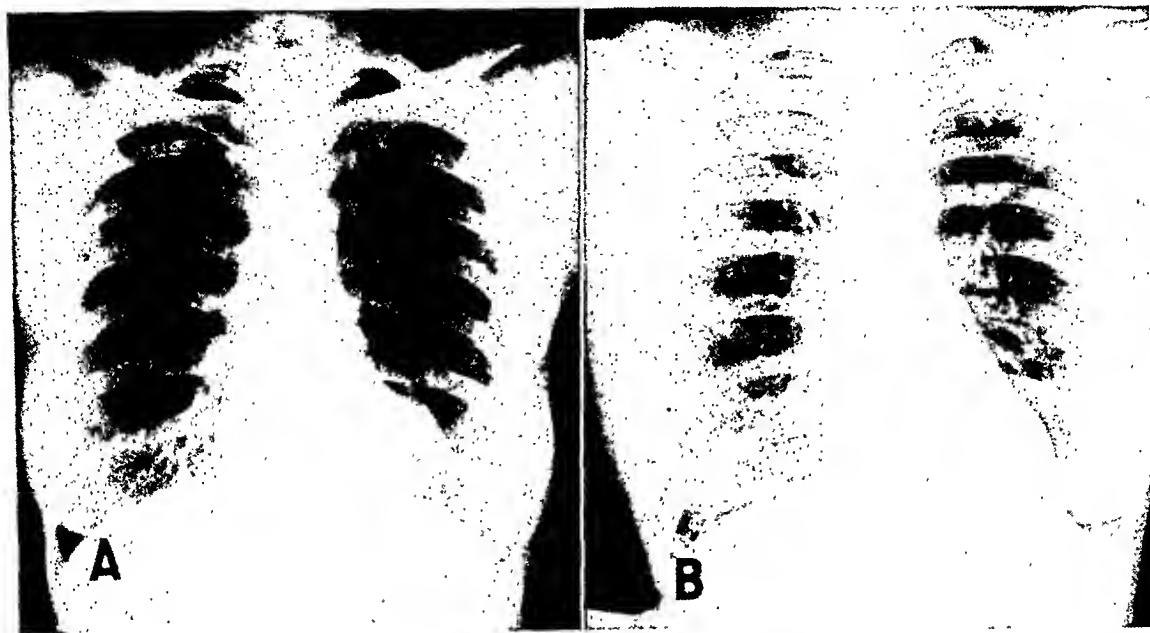


Fig. 6. A. Gumma of left ventricle, indistinguishable from tumor on x-ray films. Fluoroscopy revealed a striking paradoxical pulsation (expansion) of the protruding area with each ventricular systole.

B. One year later, after antisyphilitic treatment. Fluoroscopy still revealed slight paradoxical pulsation, which later disappeared entirely. See text for case history.

trating the same principle, many of them progressing rapidly to fatality if the true cause is not recognized and proper treatment is not instituted. A large group of cases fall in the class of heart failure due to uncontrolled abnormal types of rapid heart action. Among these are auricular tachycardia, auricular flutter, auricular fibrillation, and ventricular tachycardia. The patient with one of these conditions may progress to death in a few days, or may be restored to normal just as promptly (10). Heart failure due to pernicious anemia is another, reversible condition. The acute pancarditis of rheumatic fever may disappear entirely, leaving no damage behind. Acute diphtheritic myocarditis, heart failure due to toxemia of pregnancy, and failure due to a mechanical shunt of blood by an arteriovenous fistula are similar reversible conditions, the last in many respects quite like patent ductus arteriosus. Another and often spectacular form of reversible heart disease is the hypertension due to a Goldblatt kidney. There are many reports of cures of what seemed to be a chronic progressive

hypertensive heart disease by the removal of the offending kidney.

*Gummatous Myocarditis:* One of the rarest of these curable diseases of the heart is that due to syphilitic (gummatous) myocarditis. We have recently had such a case under observation and treatment. The fluoroscopic and roentgenographic appearances were so striking, and the improvement after antisyphilitic therapy was so marked, that I feel it is worth while to report this case again in some detail.<sup>2</sup>

Cardiovascular syphilis is rare in New England and is becoming even less common since adequate tests for syphilis and efficacious forms of therapy are in widespread use. It usually involves the aorta or the aortic valve, or both, and in this condition the response to therapy may be quite disappointing.

Our patient, M. H., was admitted to the Peter Bent Brigham Hospital March 15, 1939. She was a 39-year-old married woman who complained of continuous pain in her chest for the past two months, radiating to the left shoulder and down the left arm to the finger tips. This pain was not aggravated by exertion. It was dull, constant and aching in

<sup>2</sup> Previously reported by M. N. Fulton (6).



character, precordial in location, and was not characteristic of angina pectoris on analysis.

The real cause of the patient's admission to the hospital (so often overlooked in our official records) was an x-ray film taken in a local (county) sanatorium. This film revealed an abnormal rounded prominence on or from the left ventricle, and the patient was sent to us "for diagnosis and treatment." The chief possibilities were tumor, either primary or metastatic, and ventricular aneurysm. On fluoroscopic examination the smoothly rounded projection (Fig. 6A) was readily demonstrable, apparently arising from the anterior surface of the heart about the junction of right and left ventricles. It showed a very striking paradoxical pulsation, *i.e.*, during ventricular systole the prominence increased or expanded markedly and during diastole it decreased or flattened out. This is presumably characteristic of a ventricular aneurysm and it was so reported. A solid tumor of like size and location would show only a slight transmitted pulsation, *i.e.*, it would ride the ventricular wave or would show no pulsation at all unless it had a necrotic center which communicated with the ventricular cavity.

There followed considerable speculation as to the cause of this ventricular aneurysm. The EKG tracings revealed an abnormal form of ventricular complex but shed no light on the etiology. As the patient also had suffered from frequent nausea and vomiting for two weeks, had lost 25 lb. in weight in an indeterminate period, and was obviously ill, a gastro-intestinal examination was requested on the possibility that there might be a gastric neoplasm. The roentgen study, however, was entirely negative. There was no history of an acute attack or abrupt onset of symptoms to suggest a coronary infarct as the cause. The unexpected lead came from the routine Wassermann test, which was reported strongly positive.

To make a long story short, antisyphilitic therapy was instituted, with a prompt clinical improvement, a gradual diminution in the size of the ventricular aneurysmal bulge, and a decrease in the amplitude of the paradoxical pulsation (Fig. 6B). There was a coincident cessation of the nausea and vomiting, with a considerable gain in weight.

When the patient was last seen (May 15, 1942), the heart was normal in size and shape, the paradoxical pulsation had entirely disappeared, and

there was only the slightest fullness where the aneurysm had previously been so prominent. The EKG tracings had also reverted to normal.

\* \* \*

In summary may I urge careful attention to details in each patient with heart failure, in the hope that each of you may have the pleasure of seeing some of your patients (apparently suffering from an incurable and totally incapacitating disease) dramatically restored to health and usefulness by one of the above-mentioned means.

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# Diverticulum of the Bladder A Method of Roentgen Examination and the Roentgen and Clinical Findings in 200 Cases<sup>1</sup>

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IT IS THE PURPOSE of this report to outline a method of roentgen examination for diverticulum of the bladder and to give a brief summary of the roentgen and clinical findings in 200 cases.

Diverticulum of the bladder is a frequent and serious complication of bladder neck obstruction. Its incidence in 1,600 cases of benign hypertrophy of the prostate and carcinoma of the prostate was 9 per cent. The presence of this complication more than doubled the mortality rate of operation for relief of the bladder neck obstruction, increased the morbidity rate, and in many cases necessitated accessory operations upon the diverticulum itself before an adequately functioning bladder was obtained. Because of the frequency and seriousness of diverticulum in association with bladder neck obstruction, demonstration of the presence or absence of this complication and, if it is present, the facts with regard to it are of importance.

The clinical significance of any given diverticulum depends on its size, its position, the size of its neck, its contents, whether or not it empties spontaneously, and the condition of the bladder. The presence or absence of bladder neck obstruction or obstruction to the upper urinary tract and the nature and extensiveness of these changes are also of importance. These facts with regard to the individual case can be ascertained only by a complete examination—physical, cystoscopic, and x-ray. The most important single examination, however, is the radiographic. Without this, many cases are not recognized and

most of the desired information with regard to the diverticulum cannot be determined.

The routine roentgen examination consists essentially of three parts: (1) examination of the bladder neck and urethra; (2) upper urinary tract examination, which includes the kidneys and ureters; (3) examination of the bladder and diverticulum.

The method used to ascertain the presence or absence of prostatic and/or urethral obstruction is the cystourethrographic study which was developed by one of us (R. F.). This consists essentially of four films: (1) the flat film; (2) the opaque anteroposterior cystogram; (3) the air cystogram taken in the oblique position; (4) the cystourethrogram.

A great deal of information with regard to the bladder and urethra is obtained by this examination. The flat film shows the presence or absence of metastatic lesions in the bones and of opaque urinary calculi. The sodium iodide cystogram shows the presence or absence of diverticula, ureteral reflux, displacement of the bladder, irregularity of the bladder wall, and filling defects due to tumors or prostatic enlargement. The air cystogram shows the presence or absence of non-opaque vesical stones, enlargement of the prostate, and vesical cancer. The cystourethrogram gives more information with regard to the nature of the prostatic enlargement and at the same time shows the presence or absence of urethral stricture or any other pathologic urethral process. This method then is used as a type of examination to determine the presence or absence of a diverticulum of the bladder and to determine the presence or absence of other vesical and urethral lesions and their nature. Occasionally a diverticulum of the bladder may be missed by this examination. This

<sup>1</sup> From the Departments of Radiology and Urology of the University Hospitals, Iowa City, Iowa. The authors wish to express their appreciation to Dr. N. G. Alcock and Dr. H. D. Kerr for valuable suggestions and aid throughout the course of this study. Accepted for publication in March 1943.

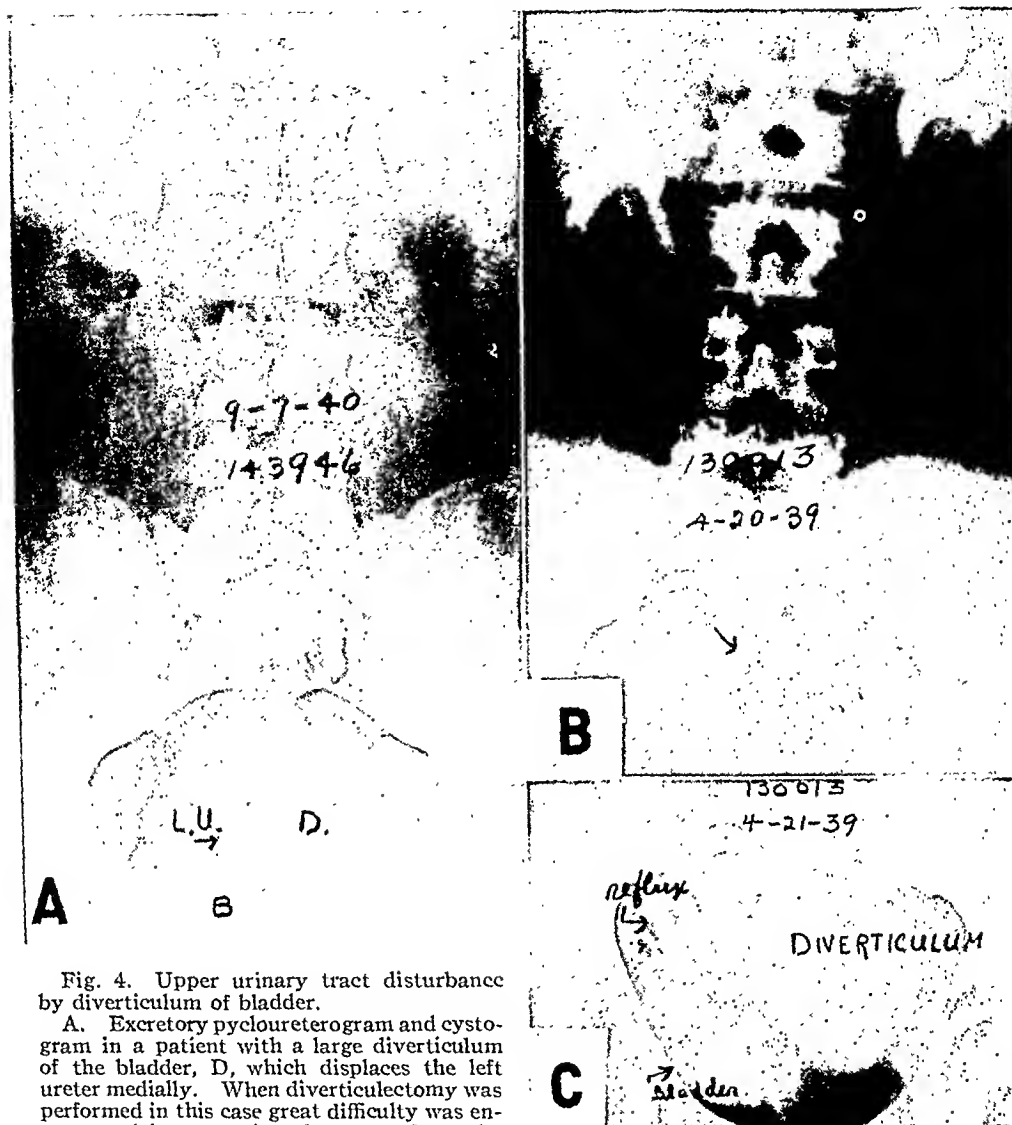


Fig. 4. Upper urinary tract disturbance by diverticulum of bladder.

A. Excretory pyeloureterogram and cystogram in a patient with a large diverticulum of the bladder, D, which displaces the left ureter medially. When diverticulectomy was performed in this case great difficulty was encountered in separating the ureter from the diverticulum wall.

B. Excretory pyeloureterogram in a patient with a large diverticulum of the bladder, showing median displacement of the lower portion of the ureter. Reimplantation of this ureter into the bladder was necessary at the time when diverticulectomy was done.

surgical therapy directed at the diverticulum is to be carried out, the disposal of the ureter must be considered. The anatomic location and the physiologic and pathologic conditions of the ureter and its kidney are therefore of importance. The ureter may have to be transplanted into a different portion of the bladder wall, the kidney may have to be removed, or the ureter may simply have to be separated from the diverticulum when diverticulectomy is performed (Fig. 4).

C. Same case as B. Cystogram showing size, location, and smooth walls of this large diverticulum. Note small irregular bladder, right ureteral reflux, and the small size and the character of the neck of the diverticulum. Observe also how well it is visualized.

In the great majority of the 200 patients examined, diverticulum of the bladder *per se* produced no changes in the upper urinary tract. In approximately 10 per cent of the cases, however, such changes were present, and when they were present, they were of definite clinical significance.

#### EXAMINATION OF THE BLADDER AND THE DIVERTICULUM

When diverticulum of the bladder is present, examination of the bladder and the

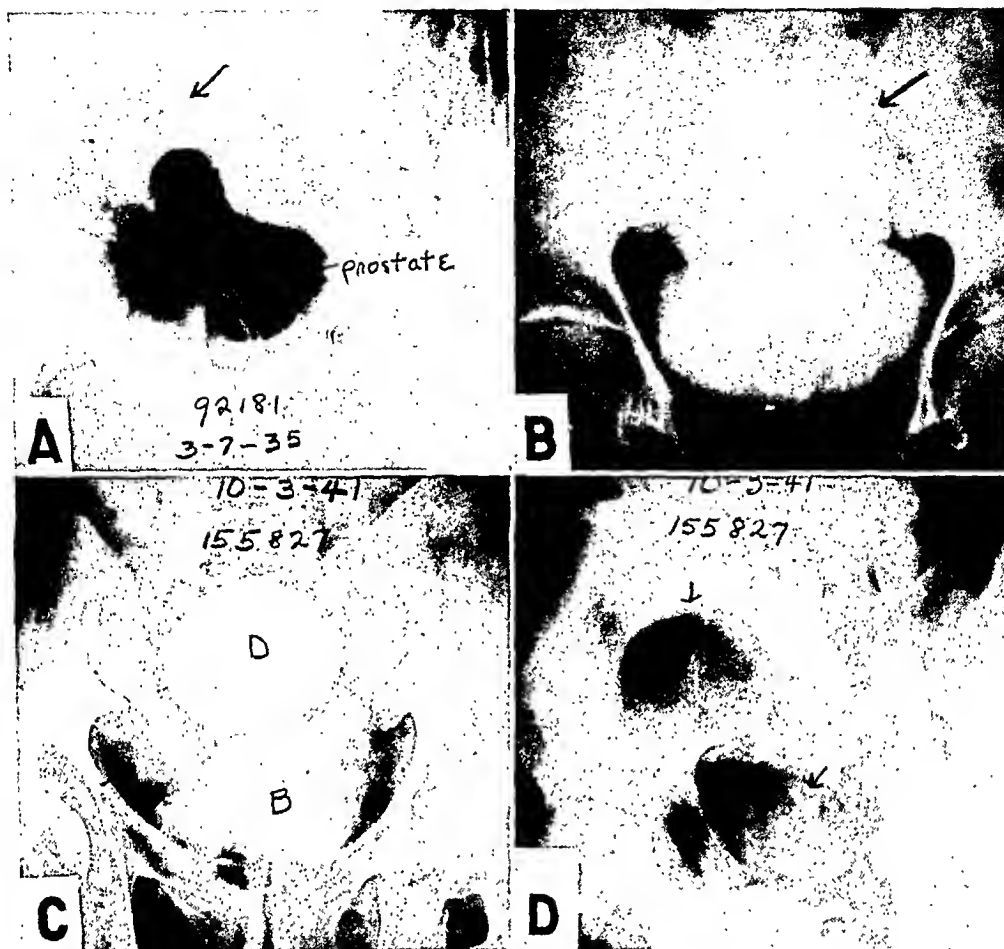


Fig. 5. Illustrating the differential diagnosis between anterior prolongation of the bladder and diverticulum of the bladder on the anterior aspect.

A and B. Cystograms in the anteroposterior and oblique positions in a patient with anterior prolongation. C and D. Same in a patient with a diverticulum of the bladder on the anterior aspect.

Note that the diverticulum is well demarcated from the bladder and that its wall is smooth, while the wall of the bladder is irregular and contains many small diverticula.

diverticulum by means of anteroposterior and right and left oblique cystography is of great value. Cystography in the anteroposterior position will indicate the size and position of the bladder, the character of the bladder wall, the number, location, and size of the diverticula, and the presence of ureteral reflux. Diverticula are usually round or oval in shape and smooth, varying in size from a small pea to many times that of the bladder itself. They are recognized and differentiated from the bladder by the nature of their walls. Occasionally the walls of the diverticulum will be rough and irregular due to the presence of infected material, tumor, or

non-opaque stones in the diverticulum. This may confuse the diagnosis, and cystoscopic examination may be necessary. Occasionally, also, a diverticulum will not be demonstrable, but its presence will be suggested by displacement of the bladder (Fig. 2), or, again, a posteriorly placed diverticulum will not be evident in the anteroposterior film. In such cases oblique films or a contrast cystogram may be of value (Figs. 2, 5, and 6).

Not only is it important to know the number, location, and size of the diverticula, but it is also important to know whether or not they are able to empty themselves. This can be determined by

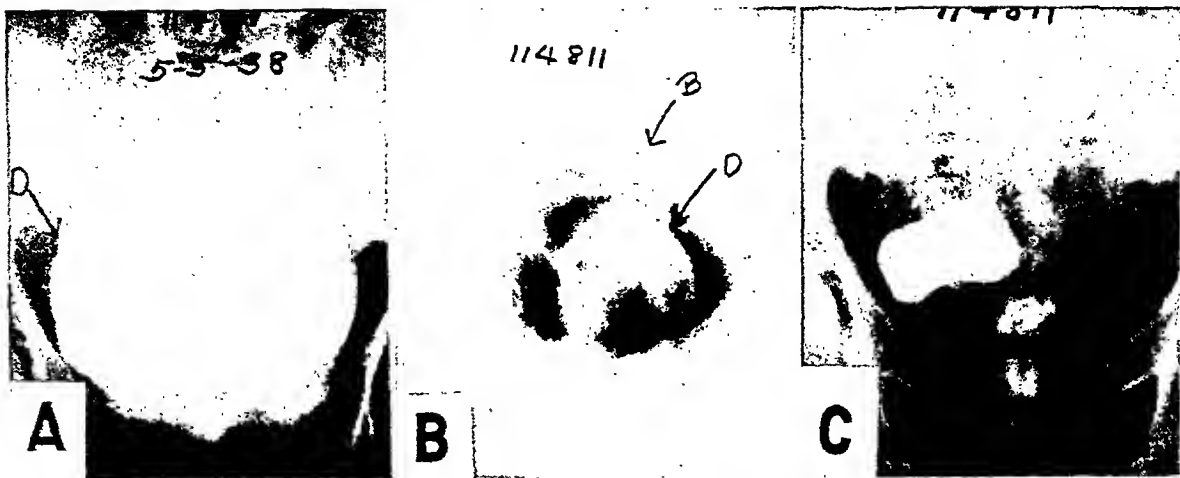


Fig. 6. Cystograms of a patient with a diverticulum on the right posterior aspect of the bladder.

A. Opaque cystogram in the anteroposterior position. Note that the diverticulum because of its location is hidden by the bladder and could easily be missed. A left oblique cystogram is necessary to demonstrate a diverticulum in this location.

B. An air cystogram made without emptying the diverticulum of the opaque medium.

C. Opaque cystogram after voiding. Note that bladder is practically completely emptied but the diverticulum is full. Diverticulotomy produced a satisfactory result.

opaque cystography. The position which best demonstrates the diverticulum in question is ascertained by the method previously described and a film is then taken with the bladder and diverticulum filled with sodium iodide solution. The patient is asked to urinate or a catheter is inserted into the bladder and the bladder is emptied. Another film is then taken, which shows whether simple emptying of the bladder or voiding produces emptying of the diverticulum (Figs. 6 and 7).

Not only is opaque cystography of value in determining the characteristics of the diverticula but it is also of value in demonstrating the results of operative procedures upon the neck of the diverticulum. Thus the effects of operative therapy upon the ability of the diverticulum to empty can be thoroughly followed (Figs. 1 and 8).

#### CLINICAL FEATURES AND TREATMENT

In the 200 cases of diverticulum of the bladder referred to above, the vast majority of the patients were over fifty years old. Of the 5 patients below fifty, 3 were between twenty and twenty-nine, 1 between thirty and thirty-nine, and 1 between forty and forty-nine. Twenty-three were in the decade fifty to fifty-nine, 67 sixty to sixty-

nine, 91 seventy to seventy-nine, and 14 eighty to eighty-nine. One hundred forty-two patients had only a single diverticulum, 38 had two, 13 had three, 1 had four, and 6 patients had more than five diverticula. In 72 cases the diverticula were between 2 and 5 cm. in diameter, in 28 between 5 and 10 cm., and in 30 over 10 cm. These figures represent the size of the largest diverticulum in each patient, as determined by measuring the greatest diameter on the x-ray film. No patient with a diverticulum under 2 cm. in diameter is included in this report.

Ninety-four diverticula were located posteriorly, 34 on the right lateral wall, 35 on the left lateral wall, and 53 anterosuperiorly. Care was taken not to include actual elongation of the bladder. If more than one diverticulum was present and one was much larger than the other, the position of only the larger one is given. The position of the diverticulum is of importance from the clinical point of view. Those situated anterosuperiorly usually empty themselves unless the neck of the diverticulum is very small. On the other hand, those situated laterally and posteriorly rarely empty, even though the obstruction is relieved. In such cases diverticulectomy

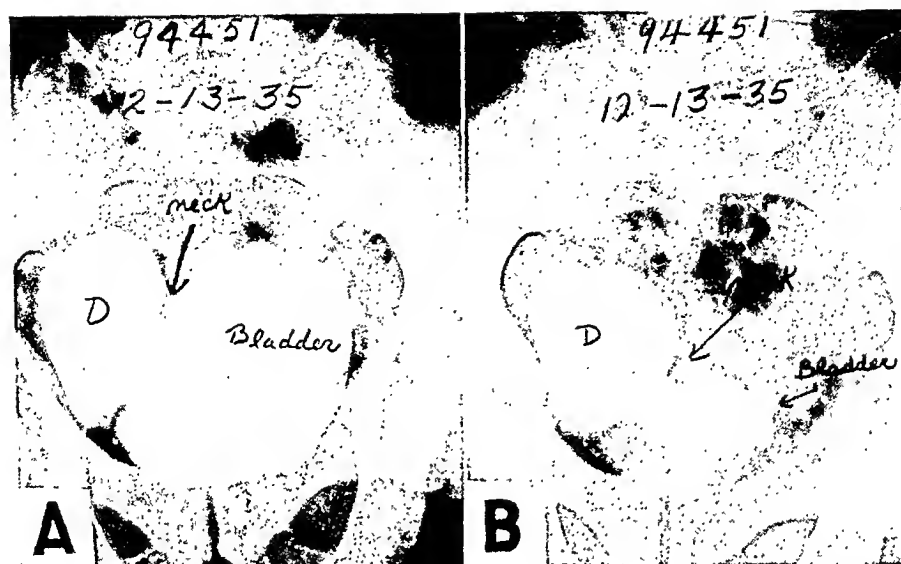


Fig. 7. Opaque cystogram before (A) and after (B) voiding. Note the large diverticulum on the right lateral aspect of the bladder which does not empty itself; also the change in size of neck of diverticulum (it becomes much smaller) as the bladder is emptying. Diverticulotomy produced a satisfactory result in this patient.

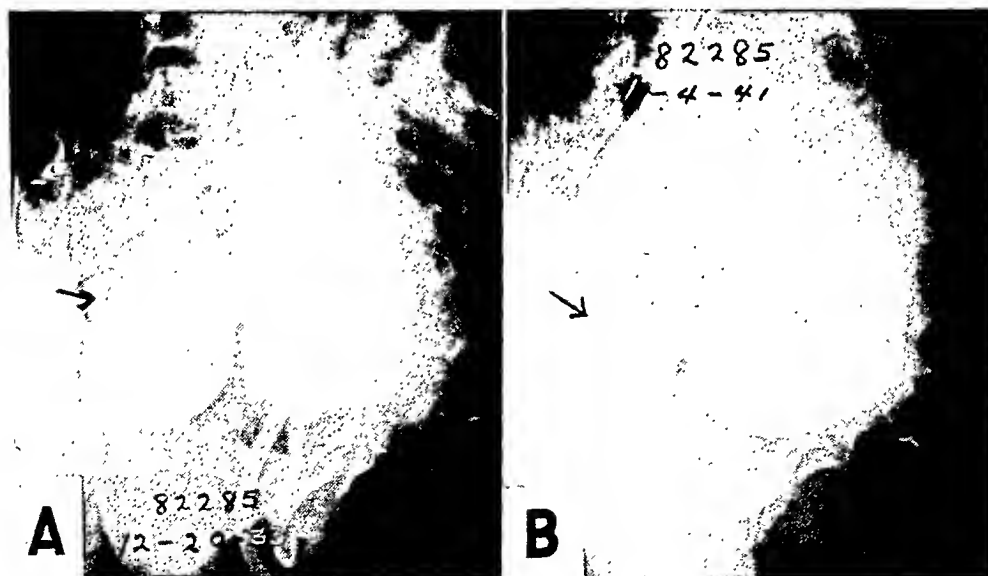


Fig. 8. Effect of relief of vesical neck obstruction upon the size of the diverticulum.

A. Cystogram made in 1933, just before transurethral prostatic resection was performed, which produced a good functional result.

B. Cystogram seven years later. Note the very definite reduction in the size of the diverticulum, which has been emptying itself satisfactorily after simple relief of vesical neck obstruction.

or diverticulotomy is indicated and must be done in order to obtain adequate emptying of the diverticulum.

The methods of treatment used in these 200 patients were as follows. In 3 patients, since both the bladder and the diverticula were emptying themselves satisfactorily, no surgical therapy was indicated. In 144 cases simple relief of the obstruction at the bladder neck or in the urethra brought about excellent functional results. In 22 cases diverticulotomy was necessary and in 9 cases diverticulectomy was required. In 19 cases no surgical therapy was instituted because of the poor condition of the patient. In 2 patients suprapubic cystostomy was done, and in 1 a urethral stricture was dilated. The following facts with regard to treatment in these 200 patients are to be emphasized: (1) In approximately 75 per cent relief of bladder neck obstruction suffices to give a good functional result. (2) Diverticulotomy gives good results in many cases and carries no increased mortality. (3) Diverticulectomy when carried out with sulfathiazole in the wound and perineal drainage of spaces about the bladder carries a low mortality. (4) Severe urinary tract infection in long standing undiag-

nosed cases may preclude any type of therapy and produces a high mortality. Any patient with pyuria must be studied for diverticulum even if the symptomatology is not marked.

#### SUMMARY

1. A method of roentgen examination of the bladder neck, urethra, upper urinary tract, the bladder, and diverticulum of the bladder is described. This method gives information with regard to the presence of pathologic changes at the bladder neck, as well as in the urethra and upper urinary tract, occurring in association with diverticula, and shows the size, position, size of neck, contents, and ease of emptying of the diverticulum itself. It also demonstrates the results of operative therapy upon the diverticulum. Illustrative examples are presented.

2. A brief summary of the roentgen and clinical findings in 200 patients with diverticula of the bladder is given.

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#### REFERENCE

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# A Review of Carcinoma of the Bladder Treated by Supervoltage X-Rays over a Five-Year Period<sup>1</sup>

FLETCHER H. COLBY, M.D., and MILFORD D. SCHULZ, M.D.

Boston, Mass.

SOMEWHAT MORE than five years ago a 1,000-kv. unit for the treatment of deep-seated malignant neoplasms was installed at the Collis P. Huntington Memorial Hospital (1) in Boston. Two and a half years ago a similar unit was installed at the Massachusetts General Hospital (2). During this five-year period 139 cases of neoplasm of the bladder have been treated by external irradiation at these two institutions, and it seems appropriate now to evaluate this form of therapy for cancer of the bladder. This report is an attempt to answer such questions as these:

1. Does our experience justify the continued use of this agent in cancer of the bladder?
2. What are the advantages or disadvantages to the patient from this form of treatment?
3. What types of tumor have responded best?
4. What have been the end-results?

The manner in which these patients were treated at both institutions is essentially as outlined by Dresser (3). Daily treatments of 300 to 400 r (in air) are given, rotating through anterior, and right and left posterior oblique pelvic ports, measuring 12 × 12 cm. The total radiation which each area receives amounts to 2,400 to 3,000 r. This course was followed by a second in three to four weeks, giving 1,200 to 1,600 r to each area; occasionally a third, smaller course was given after another three weeks. Recently, however, in view of occasional late unpleasant sequelae and the not too great hope of permanent arrest of the disease, the tendency

has been to repeat the course only as indicated by renewed activity of the growth.

The average age at onset of symptoms in the group of patients here presented was 61 years; the oldest patient was 82 and the youngest 29 years at the time of entry for treatment. Sixty-eight per cent were males, and 32 per cent females. The average delay from the time of the first significant symptom to admission for treatment was 15.7 months.

Other reports by one of us (4) on this subject have emphasized the fact that operation, as radical as is indicated, is the best method of treating malignant neoplasms of the bladder. Further experience has strengthened this opinion. We believe that localized tumors of the bladder are best treated by wide surgical excision or destruction with the high-frequency current and the implantation of radium or, in selected instances, by total cystectomy. In none of the cases included here were such procedures possible. The age and general condition of many of the patients made operation impractical; in others the growth was too extensive for surgery to be considered; and in the few instances where operation was possible it was refused. A review of the progress of some of these tumors makes one feel that total cystectomy, performed at an early stage of the disease, would have been the best solution.

Most of the patients treated by external irradiation were of advanced years, in poor condition, with extensive, often hopeless, malignant disease. In 101 cases the information regarding treatment, progress, and the final result is sufficiently complete to warrant analysis. The remaining cases were in private patients concerning whom the data are insufficient for an accurate report.

<sup>1</sup> From the Departments of Urology and of Radiology, Massachusetts General Hospital and the former Collis P. Huntington Memorial Hospital, Boston, Mass. Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.



TABLE I: CLASSIFICATION OF 101 TREATED TUMORS OF THE BLADDER

	Regression	No Regression	Cases Treated
<b>Papillary Tumors</b>			
1-a Low malignancy	1	3	4
2-a Moderate malignancy	5	16	21
3-a High malignancy	9	9	18
Total	15	28	43
<b>Non-Papillary Tumors</b>			
1-b Low malignancy	1	0	1
2-b Moderate malignancy	5	4	9
3-b High-malignancy	9	25	34
Total	15	29	44
<b>Unclassified Tumors</b>			
Sarcoma, adenocarcinoma, insufficient tissue, etc.	2	12	14
<b>GRAND TOTAL</b>	<b>32</b>	<b>69</b>	<b>101</b>

Tissue removed from treated tumors was secured in most instances and was examined by a competent pathologist. These tumor slides were kept available so they could be reviewed as the patients were seen during and after treatment and served as a valuable guide in determining which types of neoplasm responded best to treatment. We have histologic sections of 97 of the 101 treated tumors. The fact that 154 biopsies were taken shows how carefully these patients were followed. The removal of tissue by biopsy for histologic examination has been an important aid in the management of the cases.

Biopsies have not always been reliable, however, since occasionally it has been difficult to secure tissue from the viable portions of some sloughing tumors. Nor have they been as helpful as expected in enabling us to tell why some tumors respond well to treatment while others seem radioresistant. The most undifferentiated types, however, usually responded best. At times, when tumors grossly disappeared as a result of treatment, tissue removed from the site of the tumor, or from suspicious areas, showed the presence of living tumor cells, and this was an important guide to further management.

There is no generally accepted classi-

fication of bladder neoplasms. Some classification is necessary, however, since these tumors vary considerably in their characteristics, and we have grouped them as shown in Table I. Essentially there are 43 papillary and 44 non-papillary tumors in this series.

A decrease in the size of the tumor is the chief favorable effect to expect from external irradiation. In judging tumor regression in this series we have required that the growth either has disappeared, as observed by cystoscopic examination or in the opened bladder, or has shrunk to such an extent that its transurethral removal or the cystoscopic implantation of radium, previously impractical because of the extent of the tumor, has become a feasible procedure. Many tumors that seemed to have regressed considerably are not included as having regressed since they did not fulfill these qualifications. So rigid a standard was set because one's observations in this regard are not always accurate. Many tumors that grossly disappeared recurred within a short time and are included as "regressed." In evaluating the effect of external irradiation on these tumors it must also be recognized that many were treated by other agents, such as electrocoagulation and radium, with external irradiation as an added feature.

Thirty-two, or 31 per cent, of the tumors regressed under treatment. This means that in approximately one-third of the cases the tumor either disappeared or was reduced to a small fraction of its former size. Included in these 32 tumors is one case in which the biopsy report was "no tumor," although two competent observers recognized papillary growths, and another which was reported as squamous metaplasia. Of the 30 cases of unquestioned malignancy, 15 were papillary and 15 non-papillary tumors. The two types responded equally well to treatment. Of the papillary tumors, 34.8 per cent regressed, and of the non-papillary tumors 34.0 per cent. It seemed to us that the non-papillary infiltrating tumors of a high grade of malignancy (grade 3-b) showed

the most spectacular response to external irradiation, although such tumors usually recurred rapidly and responded less well to further treatment. The large papillary tumors of the lowest grade of malignancy, termed papilloma or papillary carcinoma grade 1, showed the least response of all. In other words, these tumors followed the course of cancer in general in their response to radiation, in that the more rapidly

tion and uremia. It was hoped that external irradiation would aid in preventing the multiple recurrences of these troublesome tumors, but in our experience it has been disappointing. We have treated 15 such cases. The tumors responded well in 4, or 25 per cent; they repeatedly recurred in 11, or 75 per cent, in spite of external irradiation with large doses. Early radical removal of the bladder may

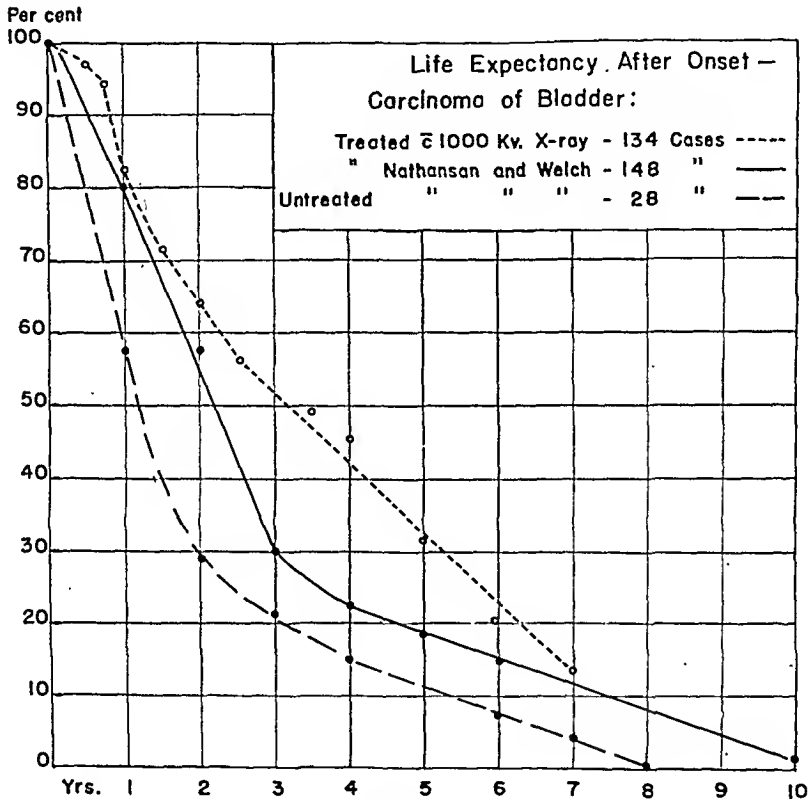


Figure 1.

growing and undifferentiated the cells, the better the effect of the radiation.

The multiple papillary tumors of moderate malignancy (grade 2-a) have been always a serious problem. Such neoplasms frequently recur in spite of any form of treatment. They seem to arise from many areas of the mucosa and so differ from the single localized tumors of the same grade of malignancy. In their early stages they appear to be surface growths but eventually they invade the deeper layers of the bladder wall and cause death by obstrue-

prove to be the best method of dealing with this type of tumor.

Relief of pain and discomfort was obtained in about one-half of the patients treated. Excessive bleeding was usually controlled, and in some instances patients were sufficiently improved in this respect so that operation became practical. Such relief of symptoms, usually accomplished without adding too much to the patient's burden, seemed particularly important in this group of cases, since no other form of treatment appeared to offer anything.

TABLE II: END-RESULTS IN 139 BLADDER TUMORS TREATED BY EXTERNAL IRRADIATION\*

Survival after Treatment, in Months	Dead			Alive				Total
	Biopsied and Followed	Refers	Total	Biopsied and Followed		Refers	Total	(Column C)
				Without Disease	With Disease			
0-6	37	6	43 (31.0%)	0	2	1	3 (2.0%)	46
7-12	16	11	27 (19.0%)	4	8	0	12 (9.0%)	39
13-18	6	8	14 (10.0%)	2	4	2	8 (6.0%)	22
19-24	5	5	10 (7.0%)	6	1	1	8 (6.0%)	18
25-36	2	0	2 (1.5%)	2	0	2	4 (3.0%)	6
37-48	1	0	1 (0.5%)	3	0	0	3 (2.0%)	4
49-60	0	0	0	2	0	0	2 (1.5%)	2
60-	0	0	0	0	0	2	2* (1.5%)	2
TOTAL	67	30	97 (69.0%)	19	15	8	42 (31.0%)	139

\* The only 2 patients who have lived longer than five years are still alive. Unfortunately they are among those who were referred to us for treatment only, and so are not included in the group used for study here. One is now known to be dying of disease.

The skin tolerated radiation well; 2,400-3,000 r (in air) to a single port caused only a moderate skin reaction. Irradiation proctitis with diarrhea and cystitis developed in most instances during the last week of treatment but could be controlled. In about 10 per cent of the patients, however, one or the other was severe enough to necessitate termination of treatment. To date no serious skin damage has come to our attention, but in 3 patients there has developed a persistent and distressing late radiation proctitis, and 2 are known to have shown severe late bladder damage. One patient had such persistent bleeding from the bladder following a total dose of over 23,000 r that it was necessary to do a skin ureterostomy and remove the bladder to control hemorrhage. The bladder showed marked fibrosis, presumably from the radiation, but no tumor was found on gross or microscopic examination. In an occasional additional case there has been evidence of fibrosis of the bladder wall.

The life expectancy of a patient with malignant disease of the bladder has, we believe, been improved (Fig. 1). Nathanson and Welch (5, 6) have published an

expectancy curve based on the cases of carcinoma of the urinary bladder seen and treated at the Huntington and Pondville Hospitals to within three years of the date at which this series begins. In our series there were 134 cases in which we could determine the date of onset of symptoms, and in which either the date of death was recorded or the patient was still alive twelve months or more after treatment.

For the first one and one-half year period—which time corresponds to the average delay in treatment—no betterment of expectancy after onset of first symptoms is indicated in our group. Improvement then seems to take place until the calculated chances of a person with carcinoma of the bladder being alive for four years after onset of disease are, in our group, 40 in a hundred as compared to 20 in a hundred in the patients seen at the Huntington Hospital before supervoltage radiation, or 15 in a hundred in untreated cases. This observation we realize is fallible; it fails to take into account advances made in other forms of treatment and cannot be taken as a record of end-results or as an actual basis for prediction.

TABLE III: EFFECT OF EXTERNAL IRRADIATION ON 101 BLADDER TUMORS

Survival after Treatment, in Months	Regression (32)			No Regression (69)		
	Dead	Alive		Dead	Alive	
		With Disease	Without Disease		With Disease	Without Disease
0-12	12	...	2	41	10	2
13-24	4	1	6	7	4	2
25-36	2	...	1	...	...	1
37-48	1	...	2	...	...	1
49-60	...	...	1	...	...	1
TOTAL	19 (59.5%)	1 (3%)	12 (37.5%)	48 (70%)	14 (20%)	7 (10%)

We do believe it is an indication of improvement in palliation, and this is borne out by clinical impressions.

Statistics of actual end-results are difficult to give with accuracy and are apt to be not too important. The rate of death and survival with and without disease, however, is shown in Table II. If we add the 38 cases not followed by us, the gross group is as shown in column C.

Of the 32 patients whose tumors were favorably affected by external irradiation, 19 have died, mostly of cancer, from two months to three years after treatment. Thirteen are living, and 12 of these are free of tumor as far as we can determine for different periods of time: 10 for over one year, 4 for over two years, 3 for over three years, and 1 for five years. It must be recognized, however, that in this small group of favorable results, agents other than external radiation were employed in many and in only 4 was radiation alone used. Of these 4, one is alive and well three years and three months, one for two years and six months, one for two years, and one for eight months. In 6 patients radon seeds were implanted in remaining bits of tumor, one was fulgurated, and one had a total cystectomy for persistent bleeding.

The response to external irradiation of some of the tumors was so striking, and their size was so reduced, that it seemed as if something additional in treatment might completely eliminate the tumor. We feared that more external irradiation might result in severe damage to the bowel or bladder, since some patients had received

as much as 18,000 to 22,000 r. Radon seeds were implanted through the cystoscope in remaining portions of the tumor in 13 such cases. Four of these patients died of cancer six to twenty-one months after treatment. Many, however, did surprisingly well. Nine, or 69 per cent, are living with no tumor visible through the cystoscope for appreciable periods of time since treatment. Thus all 9 are living and apparently well for over one year, 4 for over two years, and 2 for over four years. These cases should represent a favorable group, since the regression obtained from external irradiation showed that the tumors were radiosensitive and that further response to radium might reasonably be expected.

#### SUMMARY

We believe that patients with advanced cancer of the bladder have been benefited sufficiently by external irradiation with the 1,000-kv. unit to justify its continued use. Symptoms have been relieved in over one-half the treated cases and tumors have regressed to a marked degree in about one-third. Papillary and non-papillary neoplasms have responded equally to treatment, but in general the growths of a low grade of malignancy have responded less well than the rapidly growing, highly malignant tumors. The cases which have done best are those in which the tumors have shrunk to such size, as a result of external irradiation, that other agents, such as radium or the high-frequency current, could be employed. About 10 per cent of patients treated by external irra-

diation alone, or irradiation and other methods, have remained apparently tumor-free for one year or longer. Others have been made considerably more comfortable and their lives probably have been lengthened.

NOTE: We wish to thank Dr. George W. Holmes and Dr. Richard Dresser for their kind advice and for their help in the care of these patients, and Dr. Ronald Sniffen of the Department of Pathology, Massachusetts General Hospital, for grading the tumors.

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#### DISCUSSION

Lowell S. Goin, M.D. (Los Angeles, Calif.): At the very beginning of their paper, the essayists have pointed to the chief reason for the bad results generally encountered in the treatment of cancer of the bladder, namely, the delay in seeking treatment. The average time elapsed from the appearance of symptoms to treatment was, in their experience, 15.7 months.

This is in close agreement with my own experience. In fact, I think one could almost write the entrance history of the patient with cancer of the bladder, as follows:

"The patient noticed some blood in the urine and was greatly alarmed. Before he could make up his mind to see the doctor, the bleeding ceased and so, concluding that he probably had caught a cold on the kidneys, he felt considerably better and did nothing. After two or three weeks, bleeding again occurred. This time he was not so frightened, since he remembered that the first time the bleeding had stopped of its own accord, and so he waited for it to stop again...." and this continues until their is

total obstruction by clots or until the urine is almost pure blood.

I am not in entire agreement with the essayists' opinion that operation "as radical as may be indicated" is the best method of treating malignant disease of the bladder. I believe that resection of the bladder is the best method of treatment for a resectable tumor. The majority of bladder tumors, however, do not occur in areas which may be resected. I believe that transurethral fulguration by a competent and experienced urologist is a satisfactory method for dealing with quite small papillary lesions, provided constant observation is maintained, with the fulguration repeated as often as may be necessary.

When we grant these two methods of surgical treatment, we have left a large proportion of bladder tumors, involving the trigone, the bladder neck, or one of the ureteral orifices. If surgery is to be done for one of these tumors, it must be total cystectomy. It is likely that at the Huntington Hospital this operation is performed frequently enough to insure a good deal of skill, and that the mortality does not exceed that reported from the Memorial Hospital, namely, about 25 per cent. In general, however, the mortality is much higher than this and will usually exceed 50 per cent.

As to the implantation of radium, we have two methods at our command. We can open the bladder and implant seeds or needles, *via* suprapubic cystotomy, or we can implant seeds transurethrally. The latter is an extremely difficult procedure and it is very unusual to find a single person who combines sufficient operative skill with a cystoscope and adequate understanding of radiation. Many of you, for example, are perfectly competent to plan the irradiation of a bladder tumor by radon seeds, but I doubt if many of you could do it very well through a cystoscope. On the other hand, there are many urologists who can do very well as far as the cystoscopic surgical technic is concerned but who know too little about radium, radon, and radiation.

The method is not particularly applicable to large tumors and, regardless of size, the flat, infiltrating tumor must be implanted *via* cystotomy, since the submucous extension so common in this type of growth cannot be located with sufficient accuracy by the cystoscopic route.

If we exclude the cases which admittedly may be treated otherwise, the question becomes one as to the place of roentgen irradiation in treatment of cancer of the bladder and the type of radiation to be employed. There can be no doubt that extremely high voltage, coupled with heavy filtration, materially improves the depth dose which may be delivered to the tumor. Whether the improvement is such as to warrant the great expense involved in delivering such doses is not so clear. Most of us have not seen such large series of cases as that here reported, but it is my impression that the palliation and tumor regression following conventional high-

voltage therapy are not materially different than following supervoltage therapy.

Whether or not the wave length plays a role we will have to leave to the biophysicist, but my own experience with contact irradiation persuades me that clinically it is a great deal more important to consider how much radiant energy is delivered into the tumor than it is to select a shorter wave length.

Apparently the skin tolerated this high-voltage radiation much better than it does radiation produced at much lower voltage. Radiation proctitis and cystitis are annoying complications in most cases, and the essayists mention 3 patients with a persistent and distressing late radiation proctitis and 2 with severe late bladder distress. I think that one must hazard these sequelae if he hopes to treat malignant disease successfully.

I think it is most unfortunate that in the earlier years of radiation therapy there grew up, and is still tolerated, a supposition that, after all, if x-ray doesn't do any good, it isn't going to do much harm. Of course, we all know this isn't true—that the employment of radiation therapy in the treatment of malignant disease is a major procedure and, just as a surgeon isn't deterred from doing a hysterectomy by an expected mortality rate, say 4 per cent, so we must not be deterred from seriously attempting to cure malignant disease because we have some morbidity and even some mortality. I think we must be allowed a modest percentage of distressing sequelae and even a small mortality rate.

The tables of results accompanying the paper, when analyzed, show that the essayists divided their cases into two groups. The first group comprises those cases which showed regression during treatment. There are 32 of these, with 12 patients alive

without evidence of disease. Of these 12, however, 9 have lived less than three years and only one has lived more than four years.

The second group comprises those cases which showed little or no regression during treatment and is composed of 69 cases. Fourteen patients in this group are alive with cancer and 7 are alive without cancer. Five of the 7 have lived less than three years and only one has lived more than four years.

The total group, therefore, contains 101 cases, with 2 patients living and free from disease between four and five years after treatment. On the basis of these figures, one wonders whether supervoltage radiation offers much more hope in the treatment of this disease than the conventional methods.

Milford Schulz, M.D. (*closing*): With regard to x-ray treatment *versus* management of carcinoma of the bladder by surgery: some part of the criteria of surgical approach is dependent upon the heroism of the attending surgeon. I think, however, that we quite agree with Doctor Goin that, either because of their location or the extent of the disease, a large percentage of tumors are not surgical problems.

In reference to the point which Doctor Goin raises regarding the fact that we have just as many patients alive for more than three years without disease who had no regression as we have alive without disease in which the tumor regressed, it might be mentioned that all of these patients, when they failed to show response to radiation, were, of necessity, then considered surgical problems and had treatment such as radical surgery and extensive fulguration. All such that are alive two years or longer after radiation and free of disease had extensive treatment such as would have been given if surgery alone had been attempted without radiation.



# The Roentgenologic Diagnosis of Parasternal Omental Hernia<sup>1</sup>

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A BRIEF REVIEW of the literature concerning diaphragmatic hernia discloses little information pertaining to the roentgen diagnosis of parasternal hernia. In those cases in which the hernial contents are intestines, the diagnosis is usually obvious, because of the presence of loculated gas shadows or through the introduction of barium. When the contents of the hernia consist of a solid organ, as omentum, the diagnosis is often obscure. The location of shadows of soft tissue density in this area is suggestive of the possibility of anterior mediastinal tumor and this is often foremost in the interpreter's mind. Advance in thoracic surgery makes accurate diagnosis of lesions in the anterior mediastinum of increasing importance. It is the purpose of this paper to describe a roentgenologic sign which indicates the presence of a parasternal omental hernia.

As roentgenology has come into greater use, the recognition of diaphragmatic hernia has increased steadily (3) and today it is not considered rare. Its occurrence on the left (1) is much more frequent than on the right (5). Parasternal hernia, however, which is relatively unusual, is seen more often on the right side (2). This right-sided location may be attributed to the protection which the left costosternal triangle receives from the close attachment of the pericardium and the position of the heart. The contents of the hernia are usually colon, omentum, or both.

In the three following cases, seen at the Massachusetts General Hospital, parasternal herniae were present which appeared to pass through the right costosternal triangle. In two cases the hernia contained, at one time or another, omentum

only; in the third, the hernial contents included large intestine.

CASE 1 (BM 2074): A 67-year-old white widow entered the hospital complaining of cough of three months' duration. Its onset had been associated with an upper respiratory infection and it had at first been productive. It became non-productive three weeks before admission. There was no pain or dyspnea. The past history revealed a heart attack fifteen years before, at which time dyspnea was present for six weeks. Physical examination, as well as studies of the blood and urine, was negative.

The roentgenologic report was as follows:

"The left side of the diaphragm, left lung, and upper portion of the right lung are normal. There are apparently calcified nodes at both lung roots. The right cardiophrenic angle is obliterated by a sharply defined, rounded area of density which moves with the diaphragm and appears to change in shape with respiration [Fig. 1]. In the lateral view, the dense area is localized to the extreme anterior portion of the chest, and as the anterior ribs ascend at inspiration the mass appears to descend. The heart is slightly more to the left than normal and does not shift appreciably with respiration.

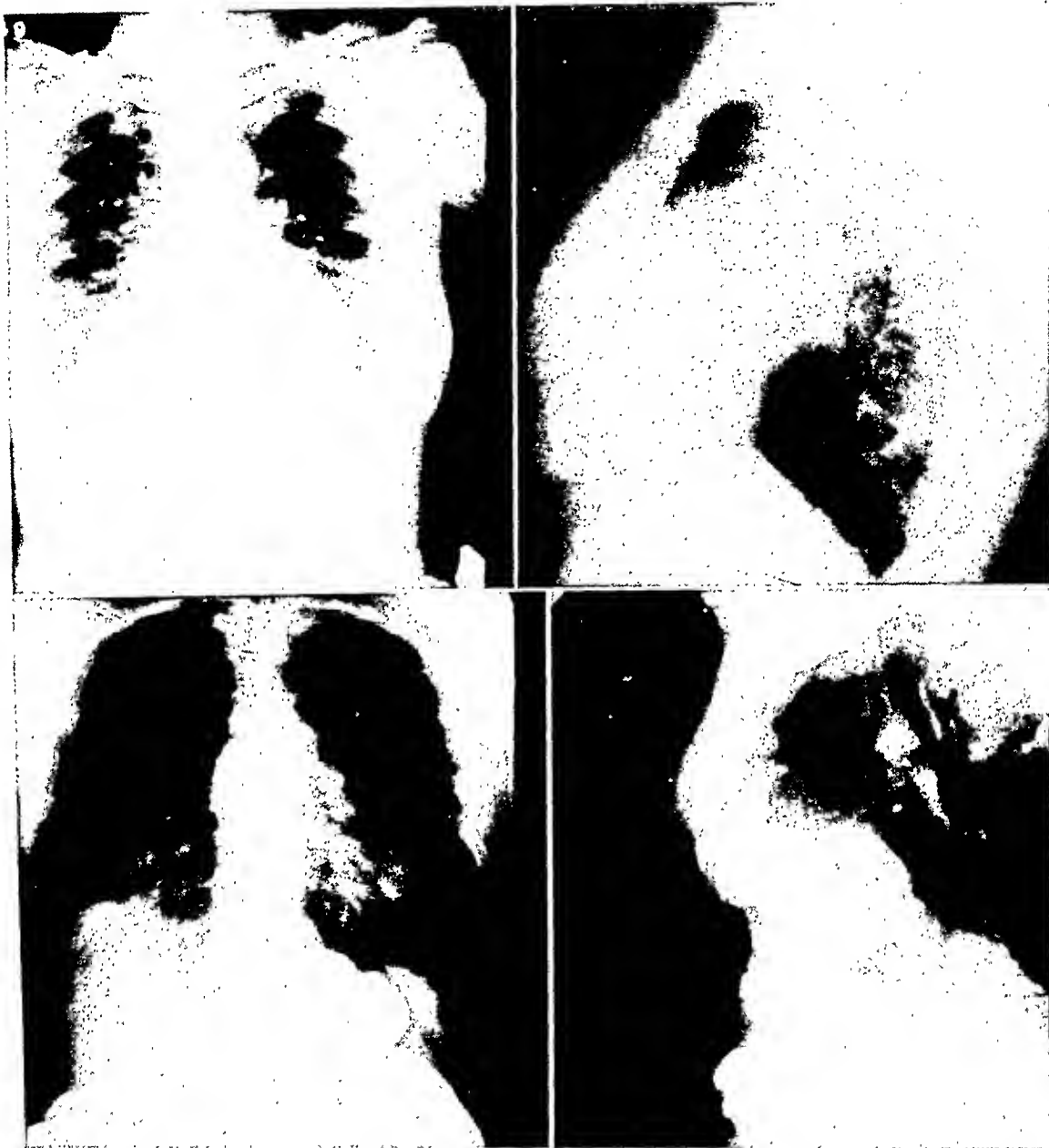
"The transverse colon and lower half of the stomach [Fig. 2] are unusually high in position and appear to ascend at deep inspiration toward the anterior and medial aspect of the right diaphragm. Neither the colon nor the stomach can be seen to pass through the diaphragm, but in certain positions they can be projected above the left diaphragm near its medial portion. As the patient stands, the stomach and colon remain in an unusually high position and appear angulated upward toward the mass in the right chest.

"This examination would seem to point to hernia of the greater omentum through the anterior part of the diaphragm near the midline."

*Comment:* Although this roentgen diagnosis was not proved, the clinical course and the findings in subsequent proved cases justify a report of the case.

CASE 2 (U-29358): A 60-year-old widow entered the hospital, complaining of pain in the region of the 10th dorsal vertebra of two years' duration. Roentgen examination revealed severe decalcification of the spine. On the films of the dorsal spine an area of density was seen in the right lower lung field and this led to a chest examination, reported as follows:

<sup>1</sup> From the Department of Radiology, Massachusetts General Hospital, Boston, Mass. Accepted for publication in April 1943.



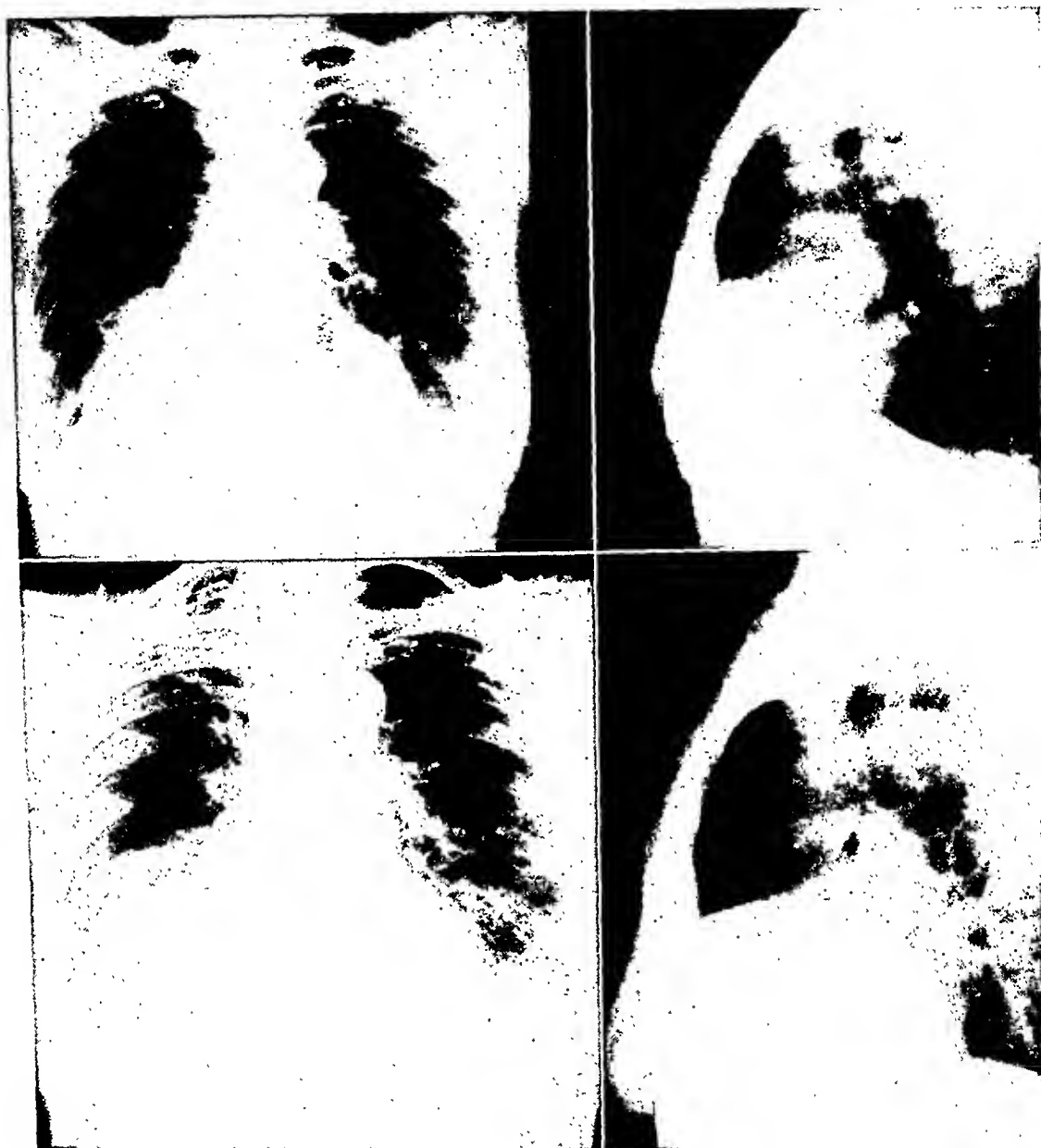
Figs. 1 and 2. Case 1: In Fig. 1 (above) a homogeneous mass is seen in the right cardiophrenic angle. The mass appeared to move downward with the diaphragm on inspiration. In Fig. 2 (below) the colon and stomach are seen to be angulated upward toward the mass in the right cardiophrenic angle, but neither organ enters the chest.

"There is a smooth, rounded mass occupying the right cardiophrenic angle [Fig. 3]. This mass, rising 6 cm. above the diaphragm, extends beyond the mid-clavicular line. The lung immediately above this shadow is emphysematous. The right lung appears displaced downward slightly. The lung fields are otherwise clear. The diaphragm moves well with respiration. The mass appears to move with the anterior ribs. The ribs do not appear grossly abnormal. There is no cavity within the mass."

The patient was examined several times over a period of nearly three years, with little change in the "mass." At the later examinations gas bubbles were seen in the area of density (Fig. 4). Barium examination of the colon (Fig. 5) showed the right side of the transverse colon anterior to the liver and extending into the right anterior chest. The antrum of the stomach and the first portion of the duodenum were retracted upward toward the hernia.

*Comment:* It is believed that the mass





Figs. 3 and 4. Case 2: In Fig. 3 (above) a homogenous mass is seen in the right anterior cardiophrenic angle. This appearance was noted over a period of approximately three years. On examination, a year later (Fig. 4, below) several gas-filled cavities were seen within the mass, which had increased in size.

when first seen represented omentum which herniated through the foramen of Morgagni and that at a later date the colon entered the hernia.

**CASE 3 (U-20313):** A 12-year-old white girl entered the Emergency Ward complaining of pain in the right lower quadrant of the abdomen. Four days prior to admission she had experienced a sudden sharp pain in this area which persisted throughout the night and interfered with sleep. She had no nausea, vomiting or diarrhea. There was a

history of tonsillectomy and adenoidectomy five years before; fracture of the left wrist two years before; and typhoid one year before. Physical examination was negative except for a systolic murmur over the precordium. Blood studies were negative.

Barium enema studies (Figs. 6 and 7) and a chest roentgenogram revealed a hernia of the colon through what appeared to be the right foramen of Morgagni.

The operative description is as follows: "Almost the entire transverse colon was in the hernial sac,

which passed through a defect in the diaphragm just to the left of the round ligament of the liver. The contents of the sac were not adherent and were readily brought back into the abdomen. The sac, which was large enough to hold the surgeon's fist, extended inwardly along the medial surface of the mediastinum and above in relation to the pleura."

Later enemas showed no evidence of recurrence.

*Comment:* This case demonstrates the case of roentgenological diagnosis when the hernial contents consist of colon.

#### CLINICAL SIGNS AND SYMPTOMS

If the patient with a parasternal omental hernia has any symptoms they are often vague and may simulate those of a thoracic or abdominal lesion. It is not certain that the symptoms in Case 1 and Case 2 were at all related to the hernia. Any atypical upper abdominal or thoracic symptomatology, however, warrants careful investigation. Physical signs may be of great value in diagnosing herniae in which the contents are intestine, but in the majority of cases recognition of diaphragmatic hernia is dependent upon roentgen examination. If laparotomy is excluded, antemortem diagnosis of omental hernia is entirely dependent on the roentgenogram.

#### ROENTGENOLOGICAL EXAMINATION

When a hernia is present, roentgenologically a shadow of soft tissue density is seen at the right cardiophrenic angle. In the lateral view the shadow lies close to the anterior chest wall. This shadow is rounded or lobulated laterally, superiorly, and posteriorly, with an anterior border conforming to the anterior chest wall. The medial border blends with the cardiac shadow and therefore is not visible. The shadow gives the appearance of a mass which, because of its location and density, suggests a mediastinal tumor such as teratoma, lipoma, lymphoblastoma, aberrant thyroid, or neurofibroma.

It is important to differentiate a mediastinal tumor from an omental hernia not only for diagnostic accuracy but because of possible surgical procedures. A barium study of the colon will be of significance in



Fig. 5. Case 2: Barium examination of the colon and stomach showed the colon to have entered the mass while the antrum of the stomach and the first portion of the duodenum were retracted upward toward the hernia.

hernia containing omentum as well as those containing large intestine. In the latter type the colon is seen to enter the hernial sac. In the former, the colon appears as an inverted "V," pointing toward the mass in the anterior cardiophrenic angle, but does not enter the mass. This configuration is a point of diagnostic importance. A gastric examination will show the antrum of the stomach also drawn upward and forward toward the mass, but the examination of the colon gives a more satisfactory and accurate localization. A



Fig. 6. Case 3: The gas-filled colon is seen in the right anterior cardiophrenic angle. The films were taken after a barium enema.



Fig. 7. Case 3: The colon is angulated upward to enter the hernia through the right anterior costosternal triangle.

combination of upward displacement of the large intestine and of the stomach in the presence of a mass in the right anterior

cardiophrenic angle gives the roentgenologist a sign by which he is able to diagnose parasternal omental hernia. If omental hernia is ruled out, alternative diagnostic procedures should be instituted.

#### SUMMARY AND CONCLUSIONS

1. Three cases of right parasternal hernia have been presented.
2. The importance of accurate roentgenological diagnosis is stressed.
3. A combination of upward displacement of the large intestine and the stomach in the presence of a mass in the right anterior cardiophrenic angle is an important diagnostic sign in omental hernia.

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# Treatment of Radiation Sickness with Vitamin B<sub>6</sub> (Pyridoxine Hydrochloride)<sup>1</sup>

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THE GREAT VARIATION in the reaction to radiation therapy has long been a source of interest. It is difficult to explain why one patient will become violently ill after radiation therapy while another will get little or no reaction from the identical type of treatment. We have not found it possible to determine accurately before treatment just which patient will respond with radiation sickness. We feel that the region of the body treated, the area of the treatment portals, and the dosage have a definite relationship to the production of this response. Its severity is apparently dependent on some inherent susceptibility in the patient. It appears justifiable to say that a patient suffering from malnutrition, debilitation, and avitaminosis will usually not tolerate radiation therapy as well as a patient in good nutritional balance.

Since the maintenance of the physical condition and general well-being of the patient at the highest possible level is the aim of all physicians, it is well for us to treat the patient as well as the disease. The radiologist, usually called as a consultant, is guilty in many instances of allowing the medical care of the patient to rest on the shoulders of the referring physician. All too frequently this means that nutritional balance will not receive adequate attention. This condition should not exist, and the radiologist who accepts a patient for treatment should insist upon an adequate program for the case as a whole, including sufficient food and fluid intake,

sufficient rest, and the maintenance of normal body functions in so far as this is possible. After these essentials have been established in the care of the patient, the radiologist should use special methods of treatment and suitable drugs to control the unusual symptoms which may occur.

Since radiation sickness is the nemesis of the therapist, it is worthy of careful consideration. The scientific studies, in the decade following 1920, of such workers as Doub, Bolliger, and Hartman (7, 8), Martin and Rogers (20), Denis and Martin (6), Warren and Whipple (33), and others, formed the basis upon which investigations have continued in this field. There have been many theories advanced as to the cause of true radiation sickness (5, 6, 7, 8, 10, 12, 17, 20, 21, 22, 23, 24, 28, 33) and many methods of treatment suggested to alleviate it (2, 3, 10, 14, 15, 16, 19, 23, 25, 26, 34, 36). The multiplicity of suggested causes and of therapeutic procedures bears evidence to the fact that there is no single method for control of this condition. It would be difficult, if not impossible, to administer to the patient all of the specified treatments which have been advocated in the last twenty years.

The introduction of the vitamin B<sub>1</sub> group as a therapeutic aid by Martin and Mour-sund (19) in 1937 seems an important step forward in the control of radiation sickness. Experimental data on animals and the actual experience on patients indicated that this was an efficient means of combating radiation nausea in a high percentage of cases. This method has been widely used and has met with an encouraging degree of success, but there are still many patients who get little or no benefit from the use of vitamin B<sub>1</sub>.

When high-potency vitamin B complex became available, this was given in increas-

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TABLE I: RESPONSE OBTAINED FROM USE OF VITAMIN B<sub>6</sub> (PYRIDOXINE HYDROCHLORIDE) IN TREATMENT OF RADIATION SICKNESS IN FIRST TWENTY-TWO CASES TREATED

Patient (Age, Color, and Sex) and Date Irradiation Was Begun	Diagnosis	Treatment	Symptoms	Vitamin B <sub>6</sub> (25 mg.) Given Intravenously	Results
R. B. (H-2514) WF 44 9-18-42	Fibroid	Pelvis: 4 portals (2AP, 2PA) 15 × 20 cm. 1,540 r to each portal; 154 r to each of 2 portals daily	9-19: Nausea and vomiting 9-25: Return of nausea	9-19; 9-25 to 9-29 daily	9-20: Patient feels well; no nausea; appetite good 9-26: No nausea; appetite good
L. S. (H-3273) CF 39 10-9-42	Ca. cervix	Pelvis: 4 portals (AP and PA) 15 × 20 cm. 2,509 r to each portal; 200 r daily to each of 2 portals	10-10: Slight nausea 10-12: Extreme nausea; patient unable to eat	10-12 to 10-14 daily	10-13: Patient much better; could take liquids. No nausea during rest of series
G. E. (H-5262) WF 33 10-26-42	Fibroid	Pelvis: AP and PA portals 20 × 20 cm. 10-25: 1,200 mg.-hr. radium 10-26: 193 r 10-27: 193 r	10-27: Extreme nausea and vomiting	10-27 to 10-29 daily	Patient began to improve 3 hours after injection; asked for "another shot"
C. R. (H-2937) WM 40 10-9-42	Bronchogenic Ca.	Left chest: 2 portals (AP and PA) 20 × 20 cm. 3,548 r to each portal; 200 r daily	10-12: Nausea and vomiting intermittently	10-14 and 10-15	10-15: Patient enjoyed food; no nausea 10-16: Patient said he was "eating like a horse." Ate well through rest of series
E. R. (H-3169) 9-21-42	Ca. cervix	Pelvis: 4 portals (AP and PA) 2,400 r to each portal; 193 r to each of 2 portals daily	9-23: Nausea and vomiting 10-8: Nausea; no appetite	9-23 10-8	Nausea and vomiting relieved until 10-8 10-9: No nausea; appetite poor, but patient ate something at every meal
D. L. (O. P. D.) 10-8-42	Ca. cervix	Pelvis: 4 portals (AP and PA) 10 × 15 cm. 2,400 r to each portal; 193 r to each of 2 portals daily	10-13: Severe nausea and vomiting; patient unable to eat. (During previous x-ray series, Sept. 1939, June 1940, March 1942, patient had severe nausea and vomiting)	10-13 to 10-20 daily	10-14: Patient began to feel better about an hour after injection; had slight nausea, but buttermilk "settled her stomach" 10-17: Patient eating fairly well; no nausea 10-19: Eating much better
R. B. B. B. B. W. B. M. C. (44958) CF 40 10-8-42	} See text for case reports				Results good Results good Results good
	Ca. cervix	Pelvis: 4 portals (AP and PA) 15 × 20 cm. 2,400 r to each portal; 200 r to each of 2 portals daily	10-10: Extreme nausea; patient vomited everything	10-10 to 10-20 daily	Vomiting relieved first day. Patient ate well after second day
L. A. W. (H-2542) WF 38 9-17-42	Chronic myelogenous leukemia	Spleen, knees, and pelvis: portals 20 × 20 cm. 798 r to spleen; 96 r to knees; 558 r to pelvis; 150 r daily	9-18: Nausea and vomiting	9-18 to 9-27 daily	General diet second day. Patient ate throughout series; no nausea or vomiting

ing doses, with the result that many who did not respond to vitamin B<sub>1</sub> seemed to fare better. There were still many patients, however, who were not relieved of radiation sickness by the use either of vitamin B<sub>1</sub> or vitamin B complex. Nicotinic acid was used by one of the authors (J. R. M.) in several cases, without apparent effect. Realizing that there were apparently other fractions in the vitamin B complex which were affording relief to certain patients, the authors turned to consideration of vitamin B<sub>6</sub> (pyridoxine hydrochloride) (32). Perusal of the literature showed this to be a safe and harmless drug; it had been widely used in certain muscular and nervous disorders (1, 4, 9, 18, 27), and a nutritional factor had been definitely established (11, 13, 29, 30, 31). Its use by Willis *et al.* (35) in the nausea and vomiting of pregnancy offered additional encouragement.

The authors began the use of vitamin B<sub>6</sub> (pyridoxine hydrochloride) intravenously, administering 25 mg. per day. It was given only in cases in which definite radiation sickness was already present. In most instances only one injection was necessary to stop the unfavorable symptoms. Some patients received the drug daily throughout the remainder of the therapy series, after the nausea ceased. Others received injections only until specific attacks of radiation sickness were checked. The authors now recommend that after the onset of radiation sickness 25 mg. be given intravenously immediately and repeated at intervals of twenty-four to seventy-two hours as needed throughout the remainder of the treatment series.

The results have been most gratifying in a series of over 50 cases. The accompanying table shows the type of radiation which was being delivered and the result obtained from the use of the drug in the first 22 cases treated. There has been only one failure to date, in a patient who was given vitamin B<sub>6</sub> intramuscularly every other day for three doses. This patient obtained no relief from the intramuscular injections, but in a subsequent series of

treatments, about eight weeks later, when the drug was given intravenously, she experienced complete relief of nausea and vomiting, in spite of difficulty of administration because of the poor condition of the veins.

Our early enthusiasm for vitamin B<sub>6</sub> in controlling radiation sickness has continued and we consider it a valuable addition to the armamentarium of the radiotherapist. But while vitamin B<sub>6</sub> is a definite adjunct to the handling of radiation sickness, it should not preclude the use of such other medication as is needed. The use of liver extract, a high-vitamin intake, sedatives, etc., when indicated, are to be encouraged. We know that there will be failures from the use of this method, since the factors of nutritional balance and general care play a part in the effectiveness of any treatment.

Reports on 3 cases of particular interest are herewith given.

Mrs. D. B. (Case G-23646), with metastatic cancer of the bony structures of the pelvis and the femurs, from a primary lesion in the breast, was admitted to the hospital June 3, 1942, with a history of severe nausea and vomiting for a week. She had not been able to retain food. A duodenal tube was immediately inserted through the nose, and nourishment was given through the tube. Glucose was administered twice daily intravenously. Nausea and vomiting continued, however, until June 17, when x-ray therapy was started with the duodenal tube still in place. The patient vomited twice while on the x-ray table and suffered extreme nausea. She was given 1 c.c. of pyridoxine hydrochloride (25 mg. vitamin B<sub>6</sub>) before leaving the department. On June 18 the duodenal tube was removed. The patient felt better than at any time in several weeks and was able to eat breakfast. No vitamin B<sub>6</sub> was given on this day. On June 19 the patient again came to the x-ray department complaining of some nausea; she had vomited once during the night. One c.c. of pyridoxine hydrochloride was given. Glucose was refused by the patient since she was able to take her special diet without vomiting. During the remainder of the treatment, which terminated July 4, she was given 1 c.c. pyridoxine hydrochloride daily. On June 27 she said that she had experienced very little nausea in the past few days, and on June 28 she enjoyed a hearty dinner. There was no further complaint of nausea and vomiting and the patient completed her x-ray series in much better condition than when she started. She was given a total of 2,400 r through two portals,

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L. S. (H-3273) CF 39 10-9-42	Ca. cervix	Pelvis: 4 portals (AP and PA) 15 × 20 cm. 2,509 r to each portal; 200 r daily to each of 2 portals	10-10: Slight nausea 10-12: Extreme nausea; patient unable to eat	10-12 to 10-14 daily	10-13: Patient much better; could take liquids. No nausea during rest of series
G. E. (H-5262) WF 33 10-26-42	Fibroid	Pelvis: AP and PA portals 20 × 20 cm. 10-25: 1,200 mg.-hr. radium 10-26: 193 r 10-27: 193 r	10-27: Extreme nausea and vomiting	10-27 to 10-29 daily	Patient began to improve 3 hours after injection; asked for "another shot"
C. R. (H-2937) WM 40 10-9-42	Bronchogenic Ca.	Left chest: 2 portals (AP and PA) 20 × 20 cm. 3,548 r to each portal; 200 r daily	10-12: Nausea and vomiting intermittently	10-14 and 10-15	10-15: Patient enjoyed food; no nausea 10-16: Patient said he was "eating like a horse." Ate well through rest of series
E. R. (H-3169) 9-21-42	Ca. cervix	Pelvis: 4 portals (AP and PA) 2,400 r to each portal; 193 r to each of 2 portals daily	9-23: Nausea and vomiting 10-8: Nausea; no appetite	9-23 10-8	Nausea and vomiting relieved until 10-8 10-9: No nausea; appetite poor, but patient ate something at every meal
D. L. (O. P. D.) 10-8-42	Ca. cervix	Pelvis: 4 portals (AP and PA) 10 × 15 cm. 2,400 r to each portal; 193 r to each of 2 portals daily	10-13: Severe nausea and vomiting; patient unable to eat. (During previous x-ray series, Sept. 1939, June 1940, March 1942, patient had severe nausea and vomiting)	10-13 to 10-20 daily	10-14: Patient began to feel better about an hour after injection; had slight nausea, but buttermilk "settled her stomach" 10-17: Patient eating fairly well; no nausea 10-19: Eating much better
R. B. B. B. B. W. B. M. C. (4958) CF 40 10-8-42	} See text for case reports				Results good Results good Results good
	Ca. cervix	Pelvis: 4 portals (AP and PA) 15 × 20 cm. 2,400 r to each portal; 200 r to each of 2 portals daily	10-10: Extreme nausea; patient vomited everything	10-10 to 10-20 daily	Vomiting relieved first day. Patient ate well after second day
L. A. W. (H-2542) WF 38 9-17-42	Chronic myelogenous leukemia	Spleen, knees, and pelvis: portals 20 × 20 cm. 798 r to spleen; 96 r to knees; 558 r to pelvis; 150 r daily	9-18: Nausea and vomiting	9-18 to 9-27 daily	General diet second day. Patient ate throughout series; no nausea or vomiting

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Patient (Age, Color, and Sex) and Date Irradiation Was Begun	Diagnosis	Treatment	Symptoms	Vitamin B <sub>6</sub> (25 mg.) Given Intravenously	Results
M. P. WF 43 9-21-42	Tumor right breast	Breast, axilla and supraclavicular regions 2,400 r to each portal; 200 r to each of 2 portals daily	Nausea after first 24 hours	9-21 to 10-12 daily	Nausea relieved; patient continued to work; ate well
J. D. (31768) WF 55 8-13-42	Ca. cervix	Pelvis: 4 portals (AP and PA) 10 × 15 cm. 2,400 r to each portal; 200 r to each of 2 portals daily	Nausea and vomiting	8-13, 8-15, 8-17	Satisfactory relief of nausea after injections
P. H. (45780) WF 39 9-16-42	Ca. cervix	Pelvis: AP and PA portals 20 × 20 cm. 2,400 r to each portal; 200 r to each of 2 portals daily	Severe nausea and vomiting at beginning of series	9-16 to 9-28 daily	No vomiting after first injection. Nausea completely relieved in a few hours. Patient ate heartily (general diet) during rest of series

20 × 20 cm., 200 r daily at 200 kv. through a Thoraeus filter (0.4 mm. Sn, 0.25 mm. Cu, 1.0 mm. Al) from June 17 through July 4, 1942. Treatment was directed toward the pelvis and right hip.

Mrs. E. B. (Case 8903) entered the hospital with a diagnosis of chronic myelogenous leukemia with an extremely high white count. X-ray therapy was started on Aug. 7, 1942. On Aug. 9 the patient arrived at the x-ray department suffering from severe nausea and vomiting. These symptoms continued for the next two days and the patient refused food. Vitamin B<sub>6</sub> (pyridoxine hydrochloride), 1 c.c., was then given intravenously; the nausea and vomiting ceased and after one day on a soft diet the patient was put on a general diet. Treatment with Vitamin B<sub>6</sub> was given daily and no further trouble was experienced. The patient continued to eat and sleep better, improving from the first injection.

Mrs. R. B. (O. P. D.) had a carcinoma of the breast. An x-ray series was given in June 1942, to the breast, axilla, and supraclavicular region. Though 5 mg. of vitamin B<sub>1</sub> (thiamine hydrochloride) were given daily throughout the series, the patient complained of nausea and some vomiting and could not take solid food.

A second x-ray series was started Sept. 18, 1942. On Sept. 23 the patient complained of extreme nausea and vomited so severely in the treatment room that she could not continue with the treatment. One c.c. of pyridoxine hydrochloride was given intravenously and the patient was put in the recovery room. Within thirty minutes she was better and the x-ray treatment was given. The patient ate lunch and supper and was much improved the next

day. The injection of vitamin B<sub>6</sub> was repeated on Sept. 25 and Oct. 8. The patient was able to eat all meals during the series and did not vomit after the first injection. When she completed her series of treatment, on Oct. 9, she said that she felt better than she had in six months.

#### SUMMARY

The use of vitamin B<sub>6</sub> (pyridoxine hydrochloride) intravenously has given us the best single method of control of radiation sickness to date. The drug is simple to administer, safe to use, and has no contraindications. It should supplement and not replace other methods used for the control of radiation sickness.

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Patient (Age, Color, and Sex) and Date Irradiation Was Begun	Diagnosis	Treatment	Symptoms	Vitamin B <sub>6</sub> (25 mg.) Given Intravenously	Results
Z. M. H. (19234) CF 19 10-7-42	Adenocarcinoma of ovary with peritoneal implants	Abdomen: 4 portals 20 × 20 cm. 1,200 r to each portal; 200 r to each portal daily	10-23: Nausea and vomiting 11-3: Return of nausea	10-23 and 11-3	Nausea checked Improvement after injection (11-3)
F. F. (48886) WF 56 10-23-42	Metastatic adenocarcinoma in skin, primary in breast (duct-cell type)	Anterior chest and breast; portal 25 cm. in diameter 2,000 r; 200 r daily	10-23: Nausea. (Patient very sick during previous series)	10-23	Nausea relieved; patient eating well
R. H. (58022) WM 4 10-20-42	Wilms' tumor	Right abdomen: AP and PA portals 20 × 20 cm. 2,400 r to each portal; 200 r daily to each of 2 portals	10-21: Extreme nausea; vomiting during treatment	10-21 to 11-1 daily	Vomiting and nausea relieved. Patient ate well and gained 2 lb. during series
R. W. (57389) CF 35 9-18-42	Ca. cervix	Pelvis: 4 portals (AP and PA) 15 × 20 cm. 2,400 r to each portal; 200 r to each of 2 portals daily	9-21: Nausea and vomiting	9-21 to 9-25 daily	No nausea or vomiting after treatment
M. S. (H-2428) 9-14-42	Draining sinus in pelvis	Pelvis: 2 portals (AP and PA) 25 cm. in diameter 579 r to each portal; 193 r daily	9-15: Extreme nausea and vomiting	9-15	Patient felt fine two hours after injection; ate the biggest lunch she had had in several weeks; dinner taken with relish; slept well and ate a breakfast "sufficient for a working-man." Feeling fine.
B. T. (O. P. D.) WF 38 9-5-42	Fibroid	Pelvis: 4 portals (AP and PA) 15 × 20 cm. Pituitary: 2 portals 10 × 10 cm. 965 r to each of pelvic portals; 193 r daily 48 r to each pituitary portal, 3 times	9-10: No appetite; some nausea 9-12: Patient could not eat breakfast	9-10 and 9-12 to 9-15 daily	9-11: Patient felt better 9-12: Ate supper. No nausea during rest of treatment
H. C. (H-358) WF 32 7-29-42	Retroperitoneal fibromyxosarcoma	Abdomen: AP and PA portals 20 × 20 cm. 3,066 r to each of 2 portals; 193 r daily to each	8-2: Nausea and vomiting severe (Severe nausea and vomiting during previous x-ray series)	8-6 to 8-14: 1 c.c. intramuscularly daily	Continued nausea and vomiting; no relief
10-15-42 (2d series)		Portals as above 924 r to each portal; 193 r daily	10-16: Severe nausea and vomiting	10-16 to 10-26 daily	Nausea relieved; patient ate all meals during treatment
R. N. (28826) WF 48 9-25-42	Ca. breast	Breast, axilla, and supraclavicular regions 2,400 r to each portal; 200 r to each of 2 portals daily	9-30: Nausea and vomiting; nothing could be taken by mouth; even water vomited	10-7 and 10-8	10-8: Nausea checked; patient asked for fruit juice 10-9: Eating regular meals

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Patient (Age, Color, and Sex) and Date Irradiation Was Begun	Diagnosis	Treatment	Symptoms	Vitamin B <sub>6</sub> (25 mg.) Given Intravenously	Results
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J. D. (31768) WF 55 8-13-42	Ca. cervix	Pelvis: 4 portals (AP and PA) 10 X 15 cm. 2,400 r to each portal; 200 r to each of 2 portals daily	Nausea and vomiting	8-13, 8-15, 8-17	Satisfactory relief of nausea after injections
P. H. (45780) WF 39 9-16-42	Ca. cervix	Pelvis: AP and PA portals 20 X 20 cm. 2,400 r to each portal; 200 r to each of 2 portals daily	Severe nausea and vomiting at beginning of series	9-16 to 9-28 daily	No vomiting after first injection. Nausea completely relieved in a few hours. Patient ate heartily (general diet) during rest of series

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The use of vitamin B<sub>6</sub> (pyridoxine hydrochloride) intravenously has given us the best single method of control of radiation sickness to date. The drug is simple to administer, safe to use, and has no contraindications. It should supplement and not replace other methods used for the control of radiation sickness.

Acknowledgments: The authors are indebted to Dr. J. G. Bieln of the Abbott Laboratories, North Chicago, Ill., for the Vitamin B<sub>6</sub> (pyridoxine hydrochloride) used in this work. They take pleasure, also, in acknowledging the assistance of their librarian, Miss K. Montgomery and their technician, Mrs. G. Kelly.

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# CASE REPORTS

## Healing of Radiation Fractures of the Necks of the Femora, with a Report of a Case<sup>1</sup>

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Since 1927, when the work of Baensch (1) drew attention to post-irradiation fractures of the femoral necks, this subject has excited a good deal of interest. Particularly has this been so in the past six years. Dalby, Jaeox, and Miller (2) helped to focus American attention on the problem with their detailed study pub-

end-result, depending upon the number of x-rays absorbed, varies from complete recovery to an obliterative endarteritis which not only inhibits repair but predisposes to a secondary aseptic necrosis years later. The microscopic picture progresses through the stages of periosteal thickening, fat replacement of marrow, sclerosis and obliteration of blood vessels, bone absorption with osteoid tissue filling-in, and neerobiosis.

We have observed a case of radiation fractures of both femoral necks, with subsequent evidence of bony healing.

TABLE I: DETAILS OF TREATMENT IN 1934 AND 1935

Air, r	Kv.	S.T.D.	Filter (mm.)	Portal	Field
12/11/34 to 1/9/35					
1,600	165	50 cm.	0.5Cu + 2Al	15 × 15 cm.	Right ant. abdomino-inguinal
1,600	165	50 cm.	0.5Cu + 2Al	15 × 15 cm.	Left ant. abdomino-inguinal
1,600	165	50 cm.	0.5Cu + 2Al	15 × 15 cm.	Right post. abdomino-inguinal
1,600	165	50 cm.	0.5Cu + 2Al	15 × 15 cm.	Left post. abdomino-inguinal
5/1/35 to 5/23/35					
1,600	165	50 cm.	0.5Cu + 2Al	15 × 15 cm.	Right ant. abdomino-inguinal
1,600	165	50 cm.	0.5Cu + 2Al	15 × 15 cm.	Left ant. abdomino-inguinal

lished in 1936, and recently Slaughter (3) has summarized the literature and added cases of fractures of bones other than the femora. Much emphasis has been placed on the rarity of healing of these fractures, since the great majority of them fail to heal at all, or do so only by fibrous union. Ewing (4) analyzed the possible end-results of radiation osteitis and radiation fractures and stated that complete bony healing is rare.

The causes of radiation fractures have been discussed by Slaughter (3) and by Ewing (4). These writers assert that the bony changes are directly proportional to the number of x-rays absorbed and that, while bone is relatively radio-resistant, its greater density increases the absorption of x-rays and enhances the production of secondary radiation. The

M. E. M., white female, aged 65, was referred to the radiologic service of the Hospital of the University of Pennsylvania on Dec. 10, 1934, for treatment of a basal-cell epithelioma of the urethra. Two months previously she had received 800 milligram hours of radium applied directly to the lesion.

Therapy, as shown in the accompanying table, was administered in doses of 200 r in air, in our Clinic, with a constant potential machine with a half-value layer of 0.9 mm of copper. At 165 kv. this machine had a 12 per cent ripple, equivalent to 200 kilovolts-peak. The estimated total depth dose was 2,600 r to the center of each femoral neck.

Because of complaints of pain in the left hip, films were made on Dec. 7, 1935. The results of examination were reported as "uncertain," with the suggestion of a possible impacted fracture through the neck of the left femur (Fig. 1A). A re-examination on Jan. 6, 1936 (Fig. 1B) revealed a fracture through the neck of the left femur which was thought to be the result of metastasis, and between Jan. 6 and Jan. 17 further treatment was directed to this region. The factors were the same as before, 1,013 r, in air, being given to a left anterior abdomino-inguinal field, 15 × 15 cm. This added an estimated depth dose of 700 r to the center of the left femoral

<sup>1</sup> From the Radiologic Clinic of the Hospital of the University of Pennsylvania, Philadelphia, Penna. Accepted for publication in April 1943.



Fig. 1. A. Dec. 7, 1935. Radiation fracture of the neck of the left femur. One can see a thin line of increased density surrounded by a narrow zone of rarefaction. The patient complained of pain and this appearance was at first mistaken for metastasis. B. Jan. 6, 1936. The extent of the process has increased.

neck, which had now received a total of 3,300 tissue r. On Feb. 20, 1936, the fracture showed evidence of healing. Serious doubt was now expressed that the area ever had been the seat of metastasis, and the

probability of a radiation fracture was suggested (Fig. 2A). Two years later, on Feb. 15, 1938, some slight symptoms of pain in the left hip persisted, but films of this region showed union in excellent

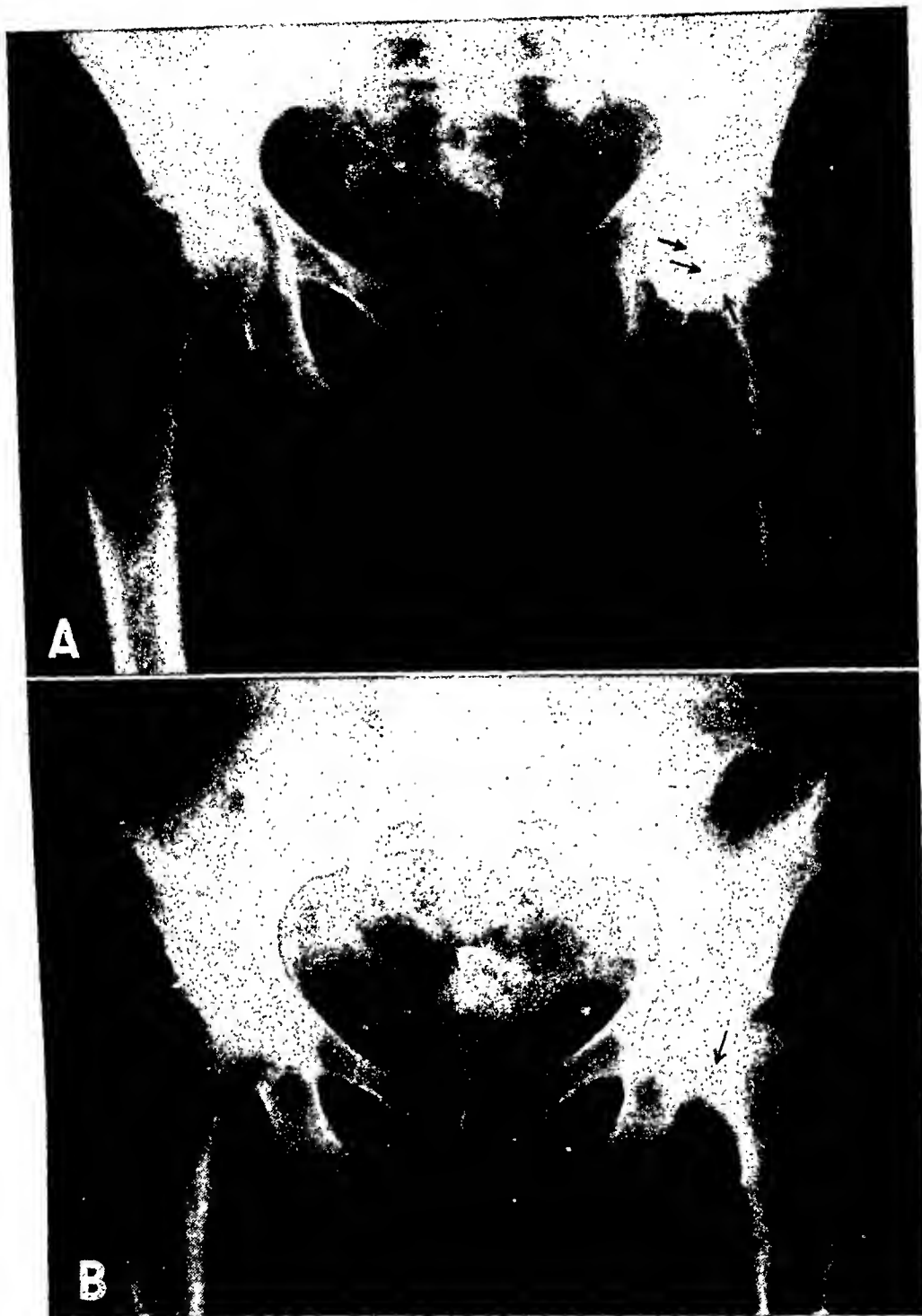


Fig. 2. A. Feb. 20, 1936. There are several zones of increased density visible at this time. The roentgen appearance has changed considerably in six weeks. B. Feb. 15, 1938. The radiation fracture of the left hip has healed, leaving only a faint zone of increased density.

position and the roentgen evidence of the fracture had almost disappeared (Fig. 2B).

On April 4, 1938, the patient was admitted to the hospital due to pain in the *right* hip, radiating in a peculiar distribution down the right side. This

had been initiated by suddenly arising from a chair. Roentgen examination showed an early radiation fracture of the neck of the right femur (Fig. 3A). On re-examination, May 28, 1938, the fracture site was more clearly apparent (Fig. 3B). A subsequent



Fig. 3. A. April 4, 1938. Radiation fracture of right hip in the same patient illustrated in Figures 1 and 2. B. May 28, 1938. The evidence of the fracture has increased and the picture simulates that seen in Figure 1B.

roentgenogram, made on Nov. 7, 1938, showed evidence of healing (Fig. 4). The patient could now walk moderately well with the aid of a cane, and while there was some pain in the right hip, the left hip was symptomless.

At this time metastatic pulmonary lesions were discovered, and death occurred on April 17, 1939.

There seems to be no indisputable explanation for the two and one-half years'



Fig. 4. A. Nov. 7, 1938. The zones of increased density in the neck of the right femur have increased. This was the last examination made before the patient died. The left hip shows only a slight density at the site of the radiation fracture which was detected three years before this examination.

discrepancy in the time of occurrence of the respective fractures in this case, other than the greater number of roentgens delivered to the left femoral neck, which fractured first. In general, and with individual differences equalized, the rapidity of development appears to be directly proportional to the number of roentgens delivered to the bone. However, there is no rigidly observed latent period before the development of post-irradiation fractures, one to five years being the usual interval.

Each fracture first manifested itself as a thin line of increased density surrounded by a narrow zone of rarefaction on the mesial aspect of the neck just distal to the femoral head. Subsequent roentgenograms showed progressive changes and two or more lines of increased density, with zones of rarefaction proximal to and between the dense bone. Bony healing was evidenced by a filling in of the less dense areas and slow loss of definition of the sharply defined zones of increased density. For a while the initial lesion in the neck of

the left femur was considered to represent a pathological fracture through an area of metastatic tumor. Serial examinations revealed the true nature of the process.

As has been reported, this patient complained of pains in the involved hip and leg for some time before the diagnosis was made. At no time prior to diagnosis was she completely incapacitated. It is recognized that these fractures were not of the complete shearing type, such as those usually reported; yet definite fractures occurred, clinically and roentgenographically, and films indicate spontaneous bony union. In both instances the only treatment of the fractures subsequent to diagnosis was bed rest and limited traction (Buck's). If the experience in this patient can be accepted, it would seem that early recognition and treatment might lead to more frequent union of the fractures that result as an unfortunate complication of irradiation.

Since the majority of radiation fractures reported have been in the femoral necks in



patients treated for carcinoma of the uterine cervix, we employ small portals, which we hope will prove of value. We do not use portals larger than 12 cm. in diameter and when using the posterior pelvic portals we caution the patient to turn her toes inward and her heels outward, thereby rotating the femora internally and throwing the femoral necks further away from the sources of radiation.

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### Carcinoma of the Trachea: Report of Two Cases Diagnosed and Treated by Roentgen Rays<sup>1</sup>

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It is difficult to explain the relative immunity enjoyed by the trachea against cancer, while the larynx and bronchi, structures in immediate continuity with the trachea, are frequent sites of new growth. A perusal of the literature, however, shows that the disease is not so rare as one is led to believe by several recent books on cancer (1-4), in which no reference is made to the existence of tracheal carcinoma. According to Culp (5) 433 tracheal tumors had been recorded up to the year 1938, 141 of which were carcinoma.

In this report we are not especially interested in the total number of cases of carcinoma of the trachea heretofore recorded but rather in the ability to diagnose the condition by the roentgen ray and its re-

sponse to treatment. According to Schinz, quoted by Weiss and Biermann (6), only 2 of the 271 intratracheal tumors known up to that time (1932) had been diagnosed and located by roentgenologic means. This is difficult to understand in view of the constant use of the x-ray in chest affections. It is, however, explained, at least in part, by a report by Vinson (7) of a tracheal tumor which could not be demonstrated on the roentgenogram, though fluoroscopic study of the esophagus and trachea showed some deformity with an apparent mass of nodes between the esophagus and trachea. Tissue removed was found to be carcinomatous and after a course of roentgen therapy the patient apparently made a complete recovery.

More definite reasons for the failure of the roentgen method are suggested by Ellinger (8), who recommends radiographic and fluoroscopic examination in both oblique positions in preference to an anteroposterior view.

We believe, then, that the failure to diagnose tracheal tumors roentgenologically may be due to use of the ordinary technic and a too close adherence to the stereoscopic examination of the chest in the anteroposterior position. In this position the trachea is practically obscured by the bones of the spine and sternum. The oblique or lateral positions, on the other hand, will reveal the outline of the trachea in its entire course. In addition, the use of a barium mixture will greatly enhance the value of the examination, revealing the presence and size of the tracheal tumor by the impression which it may produce upon the filled esophagus. The use of the roentgen method must not exclude endoscopy, which is essential. In addition to permitting direct inspection of the lesion, this makes possible removal of tissue for microscopic study and diagnosis, which are necessary to determine the mode of treatment.

We present herewith two cases of tracheal carcinoma diagnosed early and treated by x-rays.

CASE 1: F. B., male, aged 70, presented himself on Nov. 3, 1938, stating that he had been troubled

<sup>1</sup> Accepted for publication in April 1943.



Figs. 1 and 2. Case 1. Figure 1 (left) shows displacement of the esophagus by a soft mass in the lumen of the trachea. In Figure 2, taken after roentgen therapy, the mass has disappeared and the esophagus is in its normal position.

with cough and expectoration which eventually had become streaked with blood. Before long the hemorrhage became quite profuse, amounting to twenty or more mouthfuls daily. He also had postural hypotension, manifested by shortness of breath and dizziness on standing. The blood pressure varied from 116/66 in the recumbent position to 66/50 while sitting, and 50/40 standing.

The patient was studied fluoroscopically and roentgenographically in various positions, with the esophagus filled with a barium mixture. In the lateral position (Fig. 1) a shadow of a soft mass was demonstrated within the lumen of the trachea opposite the upper end of the manubrium. The segment of the esophagus contiguous to the mass was displaced backward. The diagnosis of a new growth of the trachea was made.

Endoscopic examination revealed an ulcerating, freely bleeding polypoid tumor on the posterior wall of the trachea. Esophagoscopy examination showed a narrowing of the lumen, and a specimen removed for microscopic study proved to be squamous-cell carcinoma. Roentgen treatment was begun on Nov. 10, 1938, and was continued to Dec. 11, 1938. Because of the complicating heart affection, the patient could not be treated regularly. In all he received 4,000 r distributed over 4 fields, 2 anterior and 2 posterior, with the following factors: 200 kv., 8 ma., 50 cm. distance, 2 mm. Cu + 1 mm. Al filter, 8 × 10-cm. portal, 200 r per field. The immediate

response was good. The symptoms gradually receded and the patient began to gain weight and strength. Re-examination by roentgen rays (Fig. 2) showed complete disappearance of the soft mass from the trachea and the return of the esophagus to its normal position.

On April 7, 1939, the patient returned with a recurrence of the symptoms. After only a few treatments he discontinued the series on account of aggravation of the hypotension. He died of heart failure in July 1939.

This record is presented because of the recognition of the tumor by x-ray and its disappearance after deep therapy.

CASE 2: A. F., female, aged 68, was seen on Jan. 22, 1940. In April 1939 she had experienced a dry cough, which was unproductive at first. On May 11 she had a profuse hemoptysis. She noticed that eating brought on a coughing spell, after which she expectorated blood several times. She also complained of pain and tenderness in the region of the second left anterior interspace. Physical examination was negative except for a clicking sound heard over the left upper chest on inspiration, disappearing after deep breathing.

X-ray examination of the chest was considered negative. Endoscopy, on May 16, 1939, revealed a fungating, bleeding mass in the trachea on the pos-



Figs. 3 and 4. Case 2. Tumor causing displacement of esophagus (left) and its disappearance (right) after roentgen therapy.

terior wall opposite the manubrium. A biopsy showed squamous-cell carcinoma.

The patient received x-ray treatment elsewhere with some relief of the symptoms, which, however, soon returned in an aggravated form, with severe dyspnea and profuse hemoptysis.

On Jan. 22, 1940, the patient was admitted to the Jewish Hospital because of hemorrhage, cough, and orthopnea. There was severe inspiratory and expiratory dyspnea suggesting bronchial obstruction. Upon fluoroscopic and roentgenographic examination in the oblique position (Fig. 3) a soft mass was discovered between the trachea and esophagus, with distortion and backward displacement of the esophagus opposite the manubrium.

Roentgen therapy was begun on Jan. 27, 1940, and continued to Feb. 18, 1940. Four fields were used, 2 anterior and 2 posterior. Each field received 1,650 r, making a total of 6,600 r, with the following factors: 200 kv., 25 ma., 0.5 mm. Cu + 1.0 Al filter, 50 cm. distance, 8 X 10-cm. portal. Within a short time the distressing symptoms began gradually to subside. Roentgen and endoscopic re-examination shortly after the course of treatment revealed complete disappearance of the new growth. The esophagus was regular in contour and was no longer displaced (Fig. 4).

During the past three years the patient has been re-examined by x-ray and bronchoscope several times and there has been no evidence of recurrence.

#### CONCLUSION

The two patients described above, with definite evidence of carcinoma of the trachea, have responded favorably to x-ray treatment. One is alive after three years and is in good health. The death of the other was not due solely to the carcinoma but also to a heart affection.

A so-called negative film in the presence of symptoms referable to the tracheobronchial system should lead to an examination in the oblique or lateral positions with a barium-filled esophagus.

Endoscopy, with the removal of tissue for microscopic examination, should always be done to determine the character of the growth before a decision is made as to treatment.

It goes without saying that the exact localization of the new growth and intensive roentgen therapy are absolutely imperative in order to obtain a successful result.

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# EDITORIAL

Howard P. Doub, M. D., Editor

John D. Camp, M. D., Associate Editor

## The 1943 Meeting

When Doctor Menville, as president of the Radiological Society of North America, issued the invitation to last year's meeting, he stated: "... it is our decision to hold the meeting as usual. This decision has been arrived at because of the essential part Radiology has to play in the diagnosis and treatment of war injuries." Because of this belief in the value of roentgenology to the war effort, and in the value of conventions to the home-front morale, your Board of Directors decided last December to go ahead with plans for the 1943 meeting.

Your president and his efficient program committee started to work. The response of members and non-members was overwhelming. Many more contributions to the program were submitted than could possibly be accepted, a large number being on military medicine and many from radiologists with the armed forces. I believe there are in preparation essays that will be of real value to the war effort.

Many of the authors, also, were planning scientific exhibits to present their studies more effectively. It is gratifying and encouraging that in the midst of the great efforts being put forth in routine work so many of our members and others were willing and anxious to devote extra time and thought to study, organize, and present the results of their labors. The program as planned appears on the following pages.

In the midst of all this preparation came a direct appeal from the Office of Defense Transportation. This read, in part: "The Office of Defense Transportation cannot undertake to assess the essentiality of any convention . . . the passenger transportation problem is now so serious that even those organizations whose conventions would be devoted to matters closely concerned with the war might contribute more to the war effort by cancelling their meetings." In response your Board of Directors rightly set aside their plans for the Scientific Sessions, Scientific Exhibit, Refresher Courses, and Commercial Exhibit. The method of transacting the business of the Society has yet to be decided.

But while the Scientific Sessions scheduled for December have been canceled, in the strict sense of the term, they will nevertheless be held in the pages of *RADIOLOGY*. The essayists are expected to complete the preparation of their manuscripts and submit them to the editor for publication. The papers will be read by title at whatever type of business meeting is held.

I wish personally to thank all the contributors for their co-operation, to express my regret to all our members for the omission of a meeting, and to congratulate the Board of Directors on their patriotic decision.

ROBERT S. STONE, M.D., *President*



# RADIOLOGICAL SOCIETY OF NORTH AMERICA

## SCIENTIFIC PROGRAM TWENTY-NINTH ANNUAL MEETING, 1943

The following program was arranged for the Scientific Sessions of the Twenty-ninth Annual Meeting of the Radiological Society of North America, now canceled at the request of the Government. It will be presented through the columns of RADIOLOGY in the ensuing months.

1. Role of Body-Section Radiography in the Diagnosis of Chest Diseases. LOWELL S. GOIN, M.D., Los Angeles, Calif.
2. A Gastric Filming Fluoroscope. PAUL C. HODGES, M.D., Professor of Roentgenology, University of Chicago.
3. Effect of Temperature on Speed of X-Ray Film and Intensifying Screen. RUSSELL H. MORGAN, M.D., Ass't Professor of Roentgenology, University of Chicago.
4. A Comparison of the Chemical and Roentgenographic Focal Calcium in Human Lungs. A. W. MARCOVICI, M.D., Ass't Professor of Roentgenology, and PAUL E. STEINER, M.D., Associate Professor of Pathology, University of Chicago.
5. Depression of Gastric Acidity by Irradiation. ANNA HAMANN, M.D., Ass't Professor of Roentgenology, and LILLIAN DONALDSON, M.D., Instructor in Radiology, University of Chicago.
6. Osteoid Osteoma. LILLIAN DONALDSON, M.D., Instructor in Radiology, University of Chicago.
7. Congenital Pyloric Stenosis. HERBERT LACK, M.D., 1st Lieut., M.C., O'Reilly General Hospital, Springfield, Mo.
8. The Phrenic Ampulla. GERHART SCHWARZ, M.D., Ass't in Roentgenology, University of Chicago.
9. Survival Study of Roentgen-Ray Therapy in Mammary Carcinoma. FRANK R. GRATZKE, M.D., Detroit, Mich., and K. WILHELM STENSTROM, Ph.D., Department of Radiology, University of Minnesota Hospitals.
10. Carcinoma of the Cheek, Alveolar Processes, Floor of the Mouth, and Palate. R. H. BEISWANGER, M.D., Detroit, Mich., and K. WILHELM STENSTROM, Ph.D., Department of Radiology, University of Minnesota Hospitals.
11. Malignant Tumors of the Kidney. LOUIS BIXLER, M.D., and K. WILHELM STENSTROM, Ph.D., Department of Radiology, University of Minnesota Hospitals.
12. Myelography with Iodized Oil: Experiences in the Administration and Removal of Contrast Media in Four Hundred Cases. HAROLD O. PETERSON, M.D., University of Minnesota.
13. Bronchial Adenoma. THOMAS LOWRY, M.D., and LEO G. RIGLER, M.D., University of Minnesota.
14. Clinical and Radiological Studies of Pulmonary Mycosis. WAYNE A. JOHNSTON, M.D., and J. HEYDEMANN, M.D., Dubuque, Iowa.
15. Inter-Intestinal Abscess. LEO G. RIGLER, M.D., University of Minnesota, and KENNETH L. OLSON, M.D., South Bend, Ind.
16. Flat Films of the Abdomen in Intestinal Obstruction. N. S. ZEITLIN, M.D., Chicago.
17. The Gastro-Intestinal Tract. JOSEPH C. BELL, Major, M.C., Percy Jones General Hospital, Battle Creek, Mich.
18. Foreign Bodies in the Gastro-Intestinal Tract. SAMUEL BROWN, M.D., Cincinnati, Ohio.
19. Clinical Significance of Emotional Disturbances Affecting the Roentgenologic Picture of the Stomach and Duodenum. SIDNEY A. PORTIS, M.D., Chicago, and ROBERT A. ARENS, M.D., Director, Roentgen Department, Michael Reese Hospital, Chicago.
20. Clinical Features, Diagnosis, and Treatment of Carcinoma of the Colon and Rectum. DAVID S. BEILIN, M.D., Augustana Hospital, Chicago.
21. Cerebral Arteriography. CURTIS H. BURGE, M.D., CARL F. LIST, M.D., and FRED J. HODGES, M.D., University of Michigan.
22. Arteriography as a Diagnostic Aid in Intracranial Lesions. ADOLPH HARTUNG, M.D., University of Illinois.
23. Roentgenographic Observations in Cases of Gout. EDWARD F. ROSENBERG, M.D., and ROBERT A. ARENS, M.D., Michael Reese Hospital, Chicago.
24. Solitary Congenital Pelvic Kidney. BERNARD H. NICHOLS, M.D., Cleveland Clinic, Cleveland, Ohio.
25. March Fracture, Including Others than Those of the Foot. GLENN D. CARLSON, Lieut. Colonel, M.C., and ROYAL F. WERTZ, Captain, M.C., Brooke General Hospital, Fort Sam Houston, Texas.
26. Fungus Infections of the Chest. V. L. PETERSON, Captain, M.C., Fitzsimmons General Hospital, Denver, Colo.
27. Extra-Vesicular Pathology, Causing Bladder Neck Obstruction. SAM W. DONALDSON, M.D., and RIGDON K. RATLIFF, M.D., Ann Arbor, Mich.

28. Significant Skeletal Irregularities of the Hands. JOHN F. HOLT, M.D., and FRED J. HODGES, M.D., University of Michigan.
29. Right Retro-Esophageal Aortic Arch. DAVID EISEN, M.D., Toronto, Ont.
30. Tropical Diseases of Interest to the Radiologist. L. H. GARLAND, Lieut. Commander (M.C.), U. S. Navy, San Francisco, Calif.
31. X-Ray Findings in Tropical Diseases. A. MAYORAL, Chief of X-Ray Department, Marine Hospital, New Orleans, La.
32. The Training of Army Technicians. W. W. McCAW, Colonel, M.C., Fitzsimmons General Hospital, Denver, Colo.
33. Experiences with Simultaneous Cross Irradiation. M. A. LOEBELL, M.D., Zanesville, Ohio.
34. Cancer of the Rectum. NORMAN A. McCORMICK, Windsor, Ont.
35. Supervoltage Roentgen Therapy for Carcinoma of the Esophagus. FRANZ BUSCHKE, M.D., and SIMEON T. CANTRIL, M.D., Tumor Institute of the Swedish Hospital, Seattle, Wash.
36. Further Studies Relative to the Mechanism of the Action of X-Ray Therapy in the Treatment of Bacterial Toxemia. J. DEWEY BISGARD, M.D., Omaha, Neb.
37. Effects of Radiation Therapy in Clostridium Infection in Sheep. E. A. MERRITT, M.D., A.J. DEN, M.D., and U. V. WILCOX, M.D., Washington, D. C.
38. Roentgen Therapy in Gas Bacillus Infections. SIMEON T. CANTRIL, M.D., and FRANZ BUSCHKE, M.D., Tumor Institute of the Swedish Hospital, Seattle, Wash.
39. An Improved Transvaginal Speculum. ARTHUR W. ERSKINE, M.D., Cedar Rapids, Iowa.
40. Irradiation for Brain Tumors: Follow-Up Studies, Including Postmortem Studies. T. J. WACHOWSKI, M.D., and HARVEY CHENAULT, M.D., Departments of Radiology and Neurosurgery, University of Illinois.
41. Roentgen Therapy in Diseases of the Blood-Forming Organs. RAPHAEL ISAACS, M.D., Chicago.
42. Radiation Therapy in Upper Respiratory Infections in Children. PHILIP ROSENBLUM, M.D., Chicago.
43. Radiation Therapy for Tonsillitis and Hypertrophic Lymphoid Tissue in the Pharynx. ERIK UHLMANN, M.D., Tumor Clinic, Michael Reese Hospital, Chicago.
44. Experimental Production of Extraskelctal Bone-Forming Neoplasms in the Rat. W. F. DUNNING, Ph.D., and M.R. CURTIS, Ph.D., Department of Pathology, Wayne University College of Medicine and the Detroit Institute of Cancer Research.
45. A Pathological Classification of Kidney Tumors, Review of Symptoms, Methods of Diagnosis, Therapy, and End-Results. WILLIAM E. HOWES, M.D., Clinical Director, Brooklyn Cancer Institute, Brooklyn, N. Y.
46. An Improved Technique for Treatment of Carcinoma of the Testis. MILTON FRIEDMAN, Major, M.C., and LLOYD LEWIS, Lieut. Colonel, M.C., Walter Reed General Hospital, Washington, D. C.
47. Place of the National Cancer Institute in the Cancer Program. R. R. SPENCER, M.D., Chief, National Cancer Institute, Bethesda, Md.
48. Postoperative Irradiation of Brain Tumors. FREDERICK W. O'BRIEN, M.D., and DONALD MUNRO, M.D., Boston, Mass.
49. Problem of Pneumoconiosis or Silicosis Complicated by Tuberculosis. LEWIS GREGORY COLE, M.D., New York, N. Y.
50. Relationship between X-Ray Quality Dose in Roentgens and Human Skin Erythema in Cross-Fire Technique. WALTER T. MURPHY, M.D., Buffalo, N. Y.
51. Use of Artificial Radioactive Substances in the Treatment of Neoplasm or in the Study of X-Radiation Effects on Tissue. L. MARINELLI, Memorial Hospital, New York, N. Y.
52. Roentgen Diagnosis of Aortic Aneurysms: Correlation of Roentgenologic Evidence with Necropsy Findings. JOE C. RUDE, Lieut. Colonel, M.C., Army School of Roentgenology, Memphis, Tenn., and W. C. LEVIN, M.D., University of Texas.
53. Pathogenesis of Spontaneous Pneumothorax. DAVID E. EHRLICH, Major, M.C., and R. G. MANNINO, Captain, M.C., Fort Hamilton, New York.
54. Induction of Leukemia with X-Rays. PAUL S. HENSHAW, Ph.D., National Cancer Institute, Bethesda, Md.
55. Observations on Changes in the Liver and Kidneys of Laboratory Animals, after the Application of Lethal and Sublethal Doses of X-Rays. FRIEDRICH ELLINGER, M.D., Research Associate, Department of Radiology, Long Island College of Medicine, Brooklyn, N. Y.
56. The Ureter and Its Involvement in Pelvic Irradiation. EDWARD E. MANSUR, M.D., Jefferson City, Mo.
57. Radiation Therapy of Corneal Abrasions. LEWIS G. ALLEN, M.D., Kansas City, Kan.
58. X-Ray Treatment of Sinusitis, with Special Therapy Adapter. F. C. CHRISTENSEN, M.D., Racine, Wis.
59. Bone Lesions Produced by Syphilis. JAMES R. MAXFIELD, JR., M.D., Dallas, Texas.
60. Radiation Therapy of Hemangiomas. ROBERT B. TAFT, M.D., Charleston, S. C.

61. Calcifications and Pulmonary Tuberculosis. EDWIN C. ERNST, M.D., St. Louis, Mo., and ROBERT MOORE, M.D., Vincennes, Ind.
62. Oral Cholecystography: A Comparative Study of the Single and Divided Dose Method, with Contrast Media in Liquid and Solid Form. L. W. PAUL, M.D., Associate Professor of Radiology, and E. A. POMER, M.D., Professor of Radiology, with the collaboration of R. R. BENSON, M.D., Resident in Radiology, University of Wisconsin.
63. Clinical Applications of the Broadbent Bolton Cephalometer. JOHN R. THOMPSON, D.D.S., M.S., Department of Orthodontia, University of Illinois Dental School, Chicago.
64. Respiratory Movements of the Diaphragm in Surgical Abdominal Cases. BENJAMIN D. BRAUN, M.D., and JULIUS BARON, M.D., Chicago.
65. Comparative Radiological Study of Atypical and Bacterial Pneumonia. G. H. STEIN, Captain, M.C., and P. J. KRESKY, 1st Lieut., M.C., A.A.F.T.S., Sioux Falls, S. Dakota.
66. Streamlining X-Ray Therapy for War Time Service. ALBERT SOILAND, Captain (M.C.), U.S.N.R. (Ret.—Act.), U. S. Naval Hospital, Long Beach, Calif.
67. Roentgen Detection in an Army General Hospital of Diseases Not Eliminated by Induction Boards. LUCIEN M. PASCUCCI, Major M.C., Chief of Radiological Service, O'Reilly General Hospital, Springfield, Mo.
68. Roentgen Evidence of Previously Unrecognized (Often Untreated) Fractures. J. EDWIN HABBE, M.D., Milwaukee, Wis.
- 69-71. Symposium on the Gastro-Intestinal Tract: BENJAMIN H. ORNDORFF, M.D., and others, Chicago.
72. Urokiymography. P. BOLAND HUGHES, M.D., Philadelphia, Penna.
73. Revascularization of Carpal Scaphoid and Lunate Bones. JAMES J. CALLAHAN, M.D., Chicago.
74. Primary Malignant Tumor of the Shoulder Joint: Report of a Case. HARRY A. OLIN, M.D., Woodlawn Hospital, Chicago.
75. Further Experience with Venography. EDGAR C. BAKER, M.D., Youngstown, Ohio.
76. Clinical and Surgical Aspects of Head Injuries. HAROLD C. VORIS, M.D., Chicago.
77. Radiological Diagnosis of Porencephaly. EARL R. MILLER, M.D., University of California Hospital, San Francisco.
78. Correlation of the Radiological Diagnosis with the Operative Findings in Obstructive Lesions of the Small Intestine. CLAUDE J. HUNT, M.D., Kansas City, Mo.
79. Roentgenological Diagnosis of Primary Atypical Pneumonia. ELBERT K. LEWIS, Captain, M.C., 297th General Hospital, Temple, Texas, and FRANK B. LUSK, Lieut. Colonel, M.C., X-Ray Department, Station Hospital, Fort Custer, Mich.
80. Carcinoma of the Rectum. M. MALMIN, M.D., Department of Radiology, University of Minnesota.
81. X-Ray Diagnosis of Pyloric Stenosis in Infants. H. W. HERPKE, M.D., Milwaukee Hospital and Milwaukee Children's Hospital.
82. Radiological Aspects of Osteoid Osteoma. S. A. MORTON, M.D., Columbia Hospital, Milwaukee, Wis.
83. New Positioning for Practical X-Ray Pelvimetry. A. EDWARD COLCHER, M.D., and WALTER SUSSMAN, M.D., Philadelphia, Penna.
84. Problems in the Roentgen Diagnosis of Carcinoma of the Lung. ERNEST KRAFT, M.D., F.A.C.R., New York, N. Y.
85. Responsibility of the Roentgenologist in the War-Time Duodenal Ulcer Problem. MAURICE FELDMAN, M.D., Baltimore, Md.
86. Anatomical X-Ray Studies of the Lungs, Primarily for Tuberculosis. E. C. KOENIG, M.D., Buffalo General Hospital, Buffalo, N. Y.
87. Radiation Therapy of Lymphoid Tissue in the Nasopharynx and Pharynx. HOWARD H. ASHBURY, M.D., Baltimore, Md.
88. Atypical Pneumonia with Demonstration of Pathological Material and X-Ray Findings in Several Infected Cases. H. W. GRIMM, M.D., and JAMES DENTON, M.D., New Rochelle Hospital, New Rochelle, N. Y.
89. Industrial Radiation Hazards. CARL B. BRAESTRUP, Ph.D., New York, N. Y.
90. Neurosurgery and Irradiation in Advanced Malignant Neoplasms. GEORGE COOPER, JR., M.D., and VINCENT W. ARCHER, M.D., Department of Roentgenology, University of Virginia Hospital.
91. Radiation Therapy of Malignant Growths of the Thyroid. RIEVA ROSH, M.D., and LOUIS RAIDER, M.D., C.M., Bellevue Hospital, New York, N. Y.
92. Observations on Over One Hundred Cases of Leukemia, Myelogenous and Lymphatic, with Blood and Sternal Puncture Studies and Follow-Up of Several Years. ASA B. FRIEDMAN, M.D., Brooklyn, N. Y., and LEO MEYER, M.D., Radiation Therapy Department, Kings County Hospital, Brooklyn, N. Y.
93. The A.B.C. of the Physics of X-Ray Therapy. CHESTER D. MOSES, M.D., Buffalo, N. Y.
94. (Title to be submitted later.) G. FAILLA, M.D., Columbia University, New York, N. Y.
95. (Title to be submitted later.) EDITH H. QUIMBY, Sc.D., Columbia University, New York, N. Y.



96. Roentgen Treatment of Lymphoid Tissue in the Nasopharynx. SYDNEY J. HAWLEY, M.D., George F. Geisinger Memorial Hospital, Danville, Penna.
97. Report of a Case of Erythroblastic Anemia in a Boy Eight Years Old. WILLIAM J. CORCORAN, M.D., Scranton, Penna.
98. Relationship between Morphology and X-Ray Effect on Implants of Mouse Sarcoma 180 Irradiated with 5,000 and 6,000 r. MAURICE N. RICHTER, M.D., Director, Department of Pathology, New York Post-Graduate Hospital and Medical School, and ANNA GOLDFEDER, D.Sc., M.U.C., New York University College of Medicine, New York, N. Y.
99. Further Studies on the Relation of Radiation Effects and Cell Viability. ANNA GOLDFEDER, D.Sc., M.U.C., New York University College of Medicine, New York, N. Y.
100. Angiocardiography: Anatomy of Heart in Health and Disease. HENRY K. TAYLOR, M.D., F.A.C.P., F.A.C.R., Roentgenologist, and TERESA MCGOVERN, M.D., Visiting Physician, Columbia Medical Division, Goldwater Memorial Hospital, Welfare Island, N. Y.
101. The First Twenty Years of Gastro-Intestinal Radiology—1896 to 1916. EDWARD H. SKINNER M.D., Kansas City, Mo.
102. The Latent Period in Radiation Therapy. A. MUTSCHELLER, M.D., Instructor in Radiology, New York Post-Graduate Hospital and Medical School of Columbia University, New York, N. Y.
103. Spinal Myelographic Studies with Pantopaque. WENDELL G. SCOTT, Lieut. Commander (M.C.), U.S.N.R., and LEONARD T. FURLOW, Lieut. Commander (M.C.), U.S.N.R., U. S. Naval Hospital, San Diego, Calif.



# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

**Editor's Note.**—Will secretaries of societies please cooperate by sending information to Howard P. Donb, M.D., Editor, Henry Ford Hospital, Detroit, Mich.

## UNITED STATES

**Radiological Society of North America.**—*Secretary*, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse, N. Y.

**American Roentgen Ray Society.**—*Secretary*, Harold Dabney Kerr, M.D., Iowa City, Iowa.

**American College of Radiology.**—*Secretary*, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

**Section on Radiology, American Medical Association.**—*Secretary*, J. T. Murphy, M.D., 421 Michigan St., Toledo, Ohio.

## ARKANSAS

**Arkansas Radiological Society.**—*Secretary-Treasurer*, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

## CALIFORNIA

**California Medical Association, Section on Radiology.**—*Secretary*, Joseph D. Coate, M.D., 434 Thirtieth St., Oakland.

**Los Angeles County Medical Association, Radiological Section.**—*Secretary*, Donald R. Laing, M.D., 65 N. Madison Ave., Pasadena. Meets second Wednesday of each month at County Society Building.

**Pacific Roentgen Society.**—*Secretary-Treasurer*, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Society meets annually during annual meeting of the California Medical Association.

**San Francisco Radiological Society.**—*Secretary*, Sydney F. Thomas, M.D., San Francisco Hospital. Meets monthly on third Thursday at 7:45 P.M., in Toland Hall, University of California Hospital.

## COLORADO

**Denver Radiological Club.**—*Secretary*, Edward J. Meister, M.D., 366 Metropolitan Bldg. Meetings third Friday of each month at the Denver Athletic Club.

## CONNECTICUT

**Connecticut State Medical Society, Section on Radiology.**—*Secretary-Treasurer*, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings bimonthly, on second Thursday. Place of meeting selected by Secretary.

## FLORIDA

**Florida Radiological Society.**—*Acting Secretary*, Walter A. Weed, M.D., 204 Exchange Building, Orlando.

## GEORGIA

**Georgia Radiological Society.**—*Secretary-Treasurer*, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta. Meetings twice annually, in November and at the annual meeting of State Medical Association.

## ILLINOIS

**Chicago Roentgen Society.**—*Secretary*, Warren W. Furey, M.D., 6844 S. Oglesby Ave. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

**Illinois Radiological Society.**—*Secretary-Treasurer*, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

**Illinois State Medical Society, Section on Radiology.**—*Secretary*, Fay H. Squire, M.D., 1753 W. Congress St., Chicago.

## INDIANA

**The Indiana Roentgen Society.**—*Secretary-Treasurer*, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis. Annual meeting in May.

## IOWA

**The Iowa X-ray Club.**—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

**Kentucky Radiological Society.**—*Secretary-Treasurer*, Sydney E. Johnson, M.D., Louisville City Hospital, Louisville. Meeting annually in Louisville, third Saturday afternoon in April.

## LOUISIANA

**Louisiana Radiological Society.**—*Secretary-Treasurer*, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

**Shreveport Radiological Club.**—*Secretary-Treasurer*, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at the offices of the various members.

## MARYLAND

**Baltimore City Medical Society, Radiological Section.**—*Secretary*, Walter L. Kilby, M.D., 101 W. Real St. Meetings are held the third Tuesday of each month.

## MICHIGAN

**Detroit X-ray and Radium Society.**—*Secretary-Treasurer*, E. R. Wittwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

**Michigan Association of Roentgenologists.**—*Secretary-Treasurer*, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

**Minnesota Radiological Society.**—*Secretary*, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

## MISSOURI

**Radiological Society of Greater Kansas City.**—*Secretary*, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

**The St. Louis Society of Radiologists.**—*Secretary*, Paul C. Schnobelen, M.D., 462 N. Taylor Ave. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

**Nebraska Radiological Society.**—*Secretary*, F. L. Simonds, M.D., 1216 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

## NEW ENGLAND

**New England Roentgen Ray Society** (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—*Secretary*, Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

## NEW JERSEY

*Radiological Society of New Jersey.*—Secretary, H. J. Perlberg, M.D., Trust Co. of New Jersey Bldg., Jersey City. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

## NEW YORK

*Associated Radiologists of New York, Inc.*—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave. Meetings held the fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

*Central New York Roentgen Ray Society.*—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—Secretary, Haig H. Kasabach, Presbyterian Hospital, New York, N. Y.

*Rochester Roentgen-ray Society.*—Secretary, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—Secretary, J. E. McCarthy, M.D., 707 Race St., Cincinnati. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—Secretary-Treasurer, Samuel Brown, M.D., 707 Race St. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

*The Pittsburgh Roentgen Society.*—Secretary-Treasurer, Reuben G. Alley, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—Secretary, A. M. Popma, M.D., 220 North First St., Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston. Meeting in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Texas Radiological Society.*—Secretary-Treasurer, Herman Klapproth M.D., Sherman.

## VIRGINIA

*Virginia Radiological Society.*—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond.

## WASHINGTON

*Washington State Radiological Society.*—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.*—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

## CANADA

*Canadian Association of Radiologists.*—Honorary Secretary-Treasurer, A. D. Irvine, M.D., 540 Tegler Bldg., Edmonton, Alberta.

*La Société Canadienne-Française d'Électrologie et de Radiologie Médicales.*—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

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## THE HEAD AND NECK

Case of Traumatic Ventricular Pneumocephalus. D. O. Davies. *Brit. J. Surg.* 30: 237-239, January 1943.

A man aged 59 sustained a fracture of the base of the skull. Roentgenograms revealed air in both lateral ventricles and some scattered areas of air on the surface of the brain, the whole appearance being that of a normal encephalogram. There was clinical evidence of a chronic otitis media, with a discharge from the right ear consisting of a slight amount of pus and some cerebrospinal fluid. On the fifth day following the accident symptoms of meningitis developed, with fatal termination. Autopsy revealed an extensive purulent meningitis over the base of the brain and throughout the ventricular system. There was a fracture of the right middle fossa of the base of the skull extending into the middle ear, with a tear of the dura in that region.

Four types of traumatic pneumocephalus may be recognized, according to the situation of the air: extradural, subdural, intracerebral, and ventricular. The last type may be the result of rupture of an intracerebral collection of air into the ventricle or the air may escape from the affected air sinus through the dural tear into the subarachnoid space and reach the ventricular system by the same route as does air introduced for encephalography, *via* the foramen of Lushka and Magendie in the fourth ventricle.

The author discusses the problem of early surgical intervention in cases such as that presented here, to close the dural tear and thus prevent meningitis. In the absence of middle ear infection conservative treatment is indicated, but where chronic otitis media is present, operation to prevent transfer of infection to the meninges must be considered. MAX CLIMAN, M.D.

Dermoid and Epidermoid Tumors (Cholesteatomas) of the Central Nervous System: Report of 23 Cases. C. W. Rand and D. L. Reeves. *Arch. Surg.* 46: 350-376, March 1943.

Cranial cholesteatomas (excluding those of the ear) are rare epithelial growths. They may be either intracranial or diploic. Fewer than 200 cases have been reported; the series here discussed consists of 23 cases, of which 11 were classified as diploic. This type shows a confusing clinical picture, but the x-ray finding of a sharply demarcated area of rarefaction with expansion of the tables of the skull is characteristic. Nevertheless, a diagnosis is seldom made. Complete surgical excision will lead to a cure, but recurrence is invariable if the excision is incomplete. The intracranial variety leads to symptoms similar to those produced by other brain tumors, often those of an acoustic nerve tumor. Treatment of this type is much less satisfactory, as complete excision is difficult, or at times impossible. The correct diagnosis is seldom established preoperatively.

These tumors are thought to arise from embryonic cell inclusions and are entirely different from the cholesteatomas arising in the middle ear as a result of chronic suppuration. They can be distinguished from sebaceous cysts pathologically by the absence of squamous epithelium and keratohyalin granules and by the presence of a secreting type of epithelium.

The use of the terms "epidermoid" and "dermoid" to suggest the origin of these neoplasms is preferred to the term cholesteatoma, since the latter name refers to a chemical by-product which is not necessarily present in the tumor.

The 23 case histories are given; roentgenograms and photomicrographs are reproduced, and a comprehensive bibliography is included. LEWIS G. JACOBS, M.D.

## THE CHEST

Army X-Ray Examination for Tuberculosis; Army Physical Examination Teams in Southern New York District, Second Corps Area. D. E. Ehrlich, I. A. Schiller, and H. R. Edwards. *Am. Rev. Tuberc.* 47: 113-120, February 1943.

The authors analyze the results of routine x-ray examination of the chests of National Guardsmen and Selective Service Registrants in the Southern New York District of the Second Corps Area. Up to Oct. 31, 1941, a total of 114,130 men had been examined. Prior to June 1, 1941, 14 × 17-inch paper film was used; during the period from June 1, to Oct. 31, 4 × 5-inch photoroentgenograms were employed. Of the total number of men examined, 1,304 or 1.14 per cent were rejected as unsuitable for army service because of pulmonary lesions. In 1,156 the diagnosis was pulmonary tuberculosis. Non-tuberculous lesions accounted for the remainder. Thirty-seven per cent of the tuberculous cases were considered at the time to be clinically active and in need of further care.

An examination of the figures by periods shows that, up to June 1941, the rate of rejections for pulmonary disease varied between 1.2 per cent and 1.36 per cent, but that subsequent to June 1 the rejection rate fell to 0.88 per cent. This change occurred chiefly as a result of a decline in the prevalence of arrested tuberculosis, while the prevalence of active or clinically significant disease remained essentially the same as in previous months.

Because of the amendment of the Selective Service Law, exempting men over twenty-eight from Army service, all selectees examined after July 1, 1941, were under twenty-eight years of age, and this is considered to be the responsible factor in the drop in the rejection rate, as the increase in the prevalence of tuberculosis with increasing age has been repeatedly demonstrated.

A comparison of examinations with the 14 × 17-inch paper film and the 4 × 5-inch photoroentgenograms showed that with the former method 9.3 per cent of the men rejected were certified as fit for Army service after further study, while with the 4 × 5-inch film method, 17.6 per cent of the men rejected proved to be acceptable after complete study. This was due mainly to the fact that the roentgenologists were less familiar with the interpretation of the small films and were more conservative in their readings. Many of the men subsequently found fit for service had temporary disabilities, such as bronchopneumonia, or histories suggestive of other pulmonary disease which required observation and further study. The War Department has recently designated a classification "1 A (suspended)" to include men in this category.

It has been estimated that the cost to the government is \$10,000 for every man with tuberculosis

inducted into the armed forces. On the basis of this estimate, the financial saving to the Federal Government in the elimination from service of those with known pulmonary tuberculosis would amount to \$13,000,000 for the cases reported by the authors.

L. W. PAUL, M.D.

**Case-Finding in New York City.** H. R. Edwards. *Am. Rev. Tuberc.* 47: 308-315, March 1943.

Case-finding is the major activity of the Department of Health in New York City in the prosecution of its campaign to control tuberculosis. This is carried out through the operation of routine district diagnostic clinics, a consultation service for private physicians, and mass surveys of apparently healthy adults. During a seven-year period, from 1933 to 1940, 797,759 persons were examined by these methods, and 37,339 new cases with evidence of clinically significant tuberculosis were discovered, an incidence of 5 per cent. The examination of contacts is a basic procedure in the case-finding program. Anyone, of whatever age, living with or in association with a person with active tuberculosis within the past two years is considered a contact. Some recent analyses of contact cases have indicated that about two-thirds of those to be found will be diagnosed at the time of the first examination following the discovery of the original case and that wit in two years of that date the majority will have been diagnosed. Other studies on this point are now being made; if they reveal the same findings, it will be unnecessary to supervise contacts with negative roentgenograms beyond two years from the time of breaking the contact.

Tuberculosis is more prevalent in tenement house areas and among the unemployed than among those of better social or economic surroundings. The major problem in New York City is to be found among the colored population. Surveys conducted thus far have shown consistently more tuberculous disease among the colored under twenty-five years of age than among the white population of similar economic level, whereas the reverse has been true above that age. Surveys of the adult population are of much greater importance in case-finding than are those among school children, but mass surveys of the colored of all ages are indicated.

L. W. PAUL, M.D.

**Pulmonary Manifestations in Extrapulmonary Tuberculosis: Roentgenological Study of 100 Cases.** L. Tepper and G. Jacobson. *Am. Rev. Tuberc.* 47: 156-167, February 1943.

From a review of the literature it is evident that a large percentage of patients with extrapulmonary tuberculosis have co-existing disease in the lungs and that such disease tends to show a fairly distinct roentgenologic pattern. In an attempt to substantiate these observations, the authors studied and analyzed the roentgen appearance of the chest in 100 cases of extrapulmonary tuberculosis and compared these results with the roentgen findings in 100 cases of adult pulmonary tuberculosis without evident extrapulmonary disease.

The review indicated that pulmonary post-primary lesions were found frequently in association with an extrapulmonary tuberculous focus and that these lesions within the lung differed in appearance from the usual adult type of tuberculosis. They usually showed evidence of healing, were in the main fibrous or calcific,

and apparently were the remains of an ancient infection. The roentgen characteristics of these pulmonary lesions are listed as follows:

- (1) Predominance of fibrocalcific lesions, apparently inactive.
- (2) Bilateral, symmetrical apical and subapical distribution.
- (3) Cavities, when present, thin-walled and with tendency to symmetrical distribution.
- (4) Relative absence of bronchogenic dissemination.
- (5) Evidence of regression or stability of the pulmonary lesion with superimposed hematogenous spread a not uncommon feature.

From a clinical point of view it is of importance to recognize this form of the disease because of its apparent tendency to a relatively benign and chronic course.

In the control series, in the majority of cases, there was an entirely different type of lesion, of an acute, caseous nature and with a tendency to bronchogenic spread. In a small percentage the appearance was similar to that seen in the group with extrapulmonary tuberculosis.

L. W. PAUL, M.D.

**Scaphoid Scapula in Tuberculosis.** E. Bogen and A. Rogers. *Am. Rev. Tuberc.* 47: 303-307, March 1943.

Numerous contributions on the subject of the scaphoid scapula have been made previously by Graves. He has shown that the inner border of the scapula may be either convex or concave. After the second decade of life he found a sudden and continued drop in the percentage of concave scapulae seen and a corresponding increase in the convex type, until at the eighth decade over 80 per cent of the scapulae examined were of the latter class. In groups where some form of constitutional unfitness could be postulated, the reverse appeared to be true. Graves re-examined a group of persons over a long period of time, but failed to find any definite evidence of change from one type to another, based on physical examination. He also noted that patients with tuberculosis showed a decided excess of the scaphoid type of scapulae.

The authors examined 100 patients in a tuberculosis sanatorium and found the same excess of the scaphoid type, only 23 per cent of these patients having convex scapulae. Comparison of x-ray films and physical findings in these cases showed fairly close agreement, but it is pointed out that the shape of the scapula can be much more accurately determined by means of x-ray examination. In a further x-ray study, there were found 145 convex scapulae in 633 tuberculous patients, or 23 per cent, and 97 convex scapulae in 219 healthy controls, or 44 per cent. Although convex scapulae were found less often among the tuberculous patients than among the control group of sanatorium employees, those patients with convex scapulae who were admitted to the sanatorium had no less disease and no better prognosis than those with scaphoid scapulae.

Graves was of the opinion that the form of the scapula did not change during life and that the age incidence of the scaphoid type of scapula pointed to the conclusion that many persons possessing this anomaly were in the broadest sense the poorly adaptable, the peculiarly vulnerable, the unduly disease-susceptible, and the constitutionally inferior. The authors suggest an alternative explanation based on Wolff's law, which would interpret this phenomenon as an indirect effect of the disease process, since this law states that "the

form and architecture of bone corresponds mathematically to the physical demands of external stresses."

L. W. PAUL, M.D.

**Agensis of the Lung: Report of a Case.** V. O. B. Gartside. *Brit. J. Radiol.* 16: 69-71, March 1943.

The author presents a case of agensis of the lung associated with bilateral cervical ribs and vertebral anomalies in a healthy boy of seven years. The discussion of the condition is based largely on the report of Hurwitz and Stephens (*Am. J. M. Sc.* 193: 81, 1937).

Although agensis of the lung is rarely mentioned in the textbooks, some 39 cases have been reported in the literature. Children with this condition usually die of asphyxia at birth. If they survive, the normal lung undergoes hypertrophy and assumes the function of the undeveloped organ. Physical signs are flattening of the chest, scoliosis, displacement of the apical impulse, flatness of the percussion note and absence of breath sounds on the affected side. Symptoms include dyspnea and cyanosis. It is not possible, however, to make a diagnosis on the basis of the symptoms and physical signs. X-ray examination shows a massive opacity on the affected side, with displacement of the mediastinum and trachea to this side. The diaphragm is not elevated.

Postmortem examinations have revealed two types of pulmonary agensis. In one the bronchus ends in a blind pouch, with no suggestion of lung; in the other there is a rudimentary lung which may or may not show evidence of aeration. The pleura may be present or absent. Associated abnormalities such as anal stricture, absence of the diaphragm, esophageal-tracheal fistula, accessory thymus, and hypoplasia of the face are common.

SYDNEY J. HAWLEY, M.D.

**Contributions of Roentgenology to the Diagnosis of Chronic Constrictive Pericarditis.** H. J. Stewart, J. R. Carty, and J. R. Seal. *Am. J. Roentgenol.* 49: 349-365, March 1943.

A review is given of the work of previous investigators on the recognition of chronic constrictive pericarditis and 16 cases seen by the authors since 1935 are reported, the main clinical and laboratory features and the major roentgenological observations being presented in tabular form. Pericardectomy was performed in all these cases.

The most reliable signs of the presence of an adhesive process in the pericardium appear to be the following: limitation of the lateral shift on change in position and of elongation of the heart on descent of the diaphragm, calcification in the pericardium, absence of or a small and flattened aortic knob, loss of anatomical configuration of the cardiac silhouette, pulmonary congestion, and the roentgenoscopic or roentgenkymographic demonstration of diminution of pulsation over all or part of the cardiac silhouette. When pericardial calcification is present in a patient exhibiting a compatible clinical picture, it is the most dependable sign of all. Lateral views are the most reliable in the demonstration of calcium.

The emphasis that has been placed on the small quiet heart in the diagnosis of chronic constrictive pericarditis may be justified in most cases on clinical grounds, but too strict adherence to this principle may cause one to overlook the group of cases in which there

is roentgenologic evidence of considerable enlargement of the cardiac silhouette.

There was no constant relationship between the thickness of the pericardium removed at operation and the size of the cardiac shadow in the roentgenogram.

The roentgenkymogram is of considerable aid in the diagnosis, especially in the study of the pulsations along the aorta and right border of the heart, where the amplitude of pulsation was found to be most regularly reduced. Pulsations of normal or greater than normal amplitude may be seen over portions or over all of the left border.

No constant changes in the size or appearance of the cardiac silhouette or of the aorta were observed following operation.

Dyspnea was the most common symptom, being a presenting complaint in 13 of the 16 cases studied by the authors. Ten patients had experienced enlargement of the abdomen and in 9 a noticeable degree of edema of the lower extremities had been present. The most uniform physical findings were paradoxical pulse, cyanosis, distention of the cervical veins, and increased venous pressure.

Seven of the 16 patients gave a clear history of non-specific pulmonary infection preceding the onset of symptoms. In 2 cases, there was a definite history of pericardial effusion, and in 3 others a suggestive history.

The paper is well illustrated and there is a bibliography.

CLARENCE E. WEAVER, M.D.

**Diagnosis of Congenital Heart Lesions in Children.** G. W. Grier. *Am. J. Roentgenol.* 49: 366-392, March 1943.

For purposes of study, congenital heart lesions may be classified as follows: (1) septal defects; (2) anomalous chambers; (3) anomalous great vessels; (4) valvular lesions.

Defect of the interventricular septum is a common anomaly. In the author's series of 231 cases, there were 43 in which the diagnosis was interventricular defect alone; 2 interventricular defect in combination with a dextroposed aorta; 1 in combination with a patent ductus arteriosus; 9 as a part of the tetralogy of Fallot; 15 in combination with atrial defects—a total of 70 cases. The wooden-shoe-shaped heart with the apex pushed up off the diaphragm by the enlarged right ventricle is easily recognized and quite characteristic.

Defects of the interauricular septum include patent foramen ovale, patent ostium primum, patent ostium secundum, and absence of the septum. As a result of the extra blood flowing back into the right auricle, this chamber becomes dilated, followed by an enlargement, also, of the right ventricle and pulmonary artery. Chambers of the left side of the heart are smaller than normal and the shadow of the ascending aorta and arch are very small and often not seen to the side of the spine in the roentgenogram. Interatrial defects, particularly patent foramen ovale, are not inconsistent with normal living and many patients reach early or middle adult life.

Twenty-one cases were diagnosed patent ductus arteriosus alone, and in 18 a patent ductus arteriosus occurred in combination with some other lesion. The characteristic roentgen changes are a dilatation of the pulmonary conus, usually accompanied by an enlargement of the left ventricle.

Four lesions make up the tetralogy of Fallot: ventricular septal defect, pulmonary stenosis, dextro-



position of the aorta, and hypertrophy of the right ventricle. In this condition, the heart has the wooden-shoe shape characteristic of a ventricular septal defect plus concavity in the region of the pulmonary conus produced by pulmonary stenosis, enlargement of the right heart, and displacement of the ascending aorta to the right.

In coarctation of the aorta, the intercostal arteries are dilated and these wear a groove on the under surface of the ribs, best seen from the third to the ninth. There are six pairs of aortic arches in early embryological life. The fourth left arch becomes the arch of the aorta. If this arch becomes stenotic during fetal life, the result is coarctation of the aorta; if the lumen is completely obliterated, the right arch takes its place, producing the anomaly known as persistent right aortic arch. This is readily recognized by displacement of the esophagus anteriorly and to the left as a result of the anomalous position of the right-sided aorta. In persistent truncus arteriosus, only one great trunk arises from the heart, the pulmonary artery being absent. The truncus arteriosus arises either from the right ventricle or astride the ventricular septal defect which is always present.

There are three types of anomalous chambers. In *cor biventriculare triloculare*, the septum between the auricles is absent. The roentgen appearance is not characteristic. In *cor biatriatum triloculare* a right and left auricle open into one ventricle, from which both the aorta and the pulmonary artery arise. The heart is quite large and the shadow of the great vessels smaller than normal. The right ventricle is particularly large and the pulmonary artery small. In *cor biloculare*, there is complete absence of both auricular and ventricular septa. This is very rare.

One case of tricuspid stenosis with patent foramen ovale was encountered. There were 3 cases of mitral stenosis. One case of dextrocardia was seen which was not accompanied by transposition of other organs and in which no cardiac defect could be demonstrated. This is an exception to the rule. In the remaining cases of dextrocardia in the series other anomalies were present.

It seems probable that congenital idiopathic hypertrophy is not really an entity, but an acquired enlargement from any one of many causes.

This paper contains a wealth of case histories, illustrative roentgenograms, and detailed information to which an abstract cannot do justice. Perusal of the original is recommended. C. E. WEAVER, M.D.

**Ornithosis (Psittacosis): Report of Three Cases, and Historical, Clinical, and Laboratory Comparison with Human Atypical (Virus) Pneumonia.** C. B. Favour. *Am. J. M. Sc.* 205: 162-187, February 1943.

In the past few years attention has been directed to a new, atypical form of bronchopneumonia believed to be due to a virus. Three cases seen in the Peter Bent Brigham Hospital (Boston, Mass.) have been identified as probably ornithosis (psittacosis) by the complement-fixation test. Other cases, running a parallel course but not due to the virus of ornithosis, suggested close similarities between that disease and "atypical bronchopneumonia."

As early as 1879 an unusual pneumonia which occurred after contact with tropical birds was reported, but not until 1892 did the disease assume clinical importance. Five orders and multiple species of birds,

including parrots, chickens, pigeons, and canaries, have been found to be sources of infection. For this reason, ornithosis has been suggested as a name.

It has been shown that the interstitial pneumonia seen in influenza, measles, pertussis, and other diseases is similar to that seen in ornithosis when the secondary bacterial invaders are not predominant. Comparison of the various aspects of the atypical pneumonias with those of the one probable and the 2 definite cases of ornithosis mentioned above reveals striking similarities in incubation period, prodromata, and physical signs. Acute atypical pneumonia is characterized by an interstitial pneumonia, usually without bacterial invasion, bradycardia, headache, dry cough, low or normal white count, and failure to respond to sulfonamides. Pathologically, the findings are similar to those of known virus diseases, consisting of a patchy, confluent bronchopneumonia. Vascular and perivascular lesions, reminiscent of periarteritis nodosa, are also seen.

In the absence of serologic procedures to detect the presence of latent infections, we must continue to classify the bronchopneumonias as primary bacterial, mixed bacterial and interstitial, and interstitial or atypical pneumonia. It is suggested that cases of atypical pneumonia from which no etiologic agents have been isolated may be due to a virus of the ornithosis group which has become fixed in man and is usually incapable of heterogeneous parasitism.

BENJAMIN COPLEMAN, M.D.

## THE DIGESTIVE TRACT

**Gastro-Intestinal Complaints Based on Structural Abnormalities.** T. C. Bauerlein. *Rocky Mountain M. J.* 40: 103-105, February 1943.

The author stresses the importance of some structural anomalies, particularly diaphragmatic hernia and duodenal obstruction attributable to mechanical factors, as the cause of gastro-intestinal symptoms found not to be due to the more commonly encountered pathologic entities, as cancer, ulcer, cholelithiasis, and gastritis. He reports 4 illustrative cases.

One of the patients suffered attacks of precordial distress attributed to heart disease. During these attacks, which were in reality due to dietary indiscretions with resultant hyperacidity and aerophagia, he always reclined. He was found to have a transverse stomach and a high diaphragm, which prevented expulsion of gas in the recumbent position. When he was persuaded to stand he was able to relieve the gastric distention by eructation, and the pain disappeared.

The second patient had, in addition to some degree of myocardial damage, a large esophageal hiatus which permitted herniation of the stomach when the supine position was assumed. This resulted in severe cardiac symptoms either reflex or due to compression of the already damaged heart by the herniated stomach.

In the third case the esophagus was found to enter the stomach at a relatively low level so that gas accumulated in its upper pole without being able to escape through the cardia. This patient obtained relief by lying down, which permitted a wider distribution of the gas over the stomach.

The fourth patient, a 22-year-old girl, gave evidence of duodenal stasis. Symptoms were relieved by a high caloric diet and a regimen which included lying down



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Of 189 patients who died, necropsy was performed on 70. In the latter group 40 patients had carcinoma or other malignant neoplasia; 17 had cirrhosis, and the remaining 13 such miscellaneous conditions as myeloid leukemia, pernicious anemia, tuberculosis, and heart disease. Sixteen patients died within 24 hours of administration of thorotrast, while 17 expired between one day and one week following the injections.

It is remarkable that patients who had had serious diseases of the liver lived longer, in most instances, than was anticipated. Furthermore, fewer attacks of infectious diseases, including colds, were found in this group as compared to the general population. The immunity mechanism of the body was definitely not depressed by the presence of thorotrast in the reticulo-endothelial cells.

Twelve cases illustrated with roentgenograms are reported in detail.

The greatest usefulness of hepatosplenography is in diagnosing early cirrhosis, metastases, and abscess of the liver. *Cirrhosis* of the liver is recognized by a diffuse mottling or reduced liver density, often with changes in size or configuration of that organ. *Metastases* in the liver are denoted by rounded areas of lessened density, surrounded frequently by a halo of increased density. *Abscess* produces a rounded area of reduced density, usually without the halo.

Little help has been obtained from follow-up films. The usual change is a diffuse punctate or interlacing linear mottling and opacity of the upper abdominal lymph nodes.

The findings in the spleen are usually not of much diagnostic import. STEPHEN N. TAGER, M.D.

**Relationship Between Roentgenographic Abnormalities of the Gall Bladder and Constipation.** G. H. Laing, J. M. Beazell, and A. C. Ivy. *Am. J. Digest. Dis.* 10: 50-51, February 1943.

Because of numerous reports indicating a definite relationship between disturbances of the colon and evacuation of the gallbladder, a series of 372 cases was analyzed, in which the patient had been subjected to a complete gastro-intestinal roentgen examination. In this group 24.4 per cent of the patients complained of constipation. Although the gallbladder appeared to empty more slowly in these cases, the incidence of gallbladder disease and gallstones was no higher than in the patients who did not complain of constipation.

JOSEPH T. DANZER, M.D.

## THE SKELETAL SYSTEM

**Slow Union of Fractures, with a Study of 804 Fractures of the Shafts of the Tibia and Femur.** R. Watson-Jones and W. D. Coltart. *Brit. J. Surg.* 30: 260-276, January 1943.

The impression that fractures of the shaft of the femur and tibia are uniting more slowly than in former years has gained wide acceptance. It has appeared that recent methods of treatment have doubled or trebled the time required for union. This may be accounted for by two great changes in the principles of fracture therapy distinguishing the practice of today from that of thirty years ago: (1) the present tendency to demand evidence of radiographic consolidation rather than clinical union alone; (2) the present belief that all fractures unite if they are immobilized long enough and that non-union is never inevitable. While

clinical union may occur in from six to eight weeks, radiographic consolidation, as demonstrated by uniform calcification of the callus, is not completed until many weeks later. It is now recognized that only the minimum period for union can be fixed and that, if immobilization is continued long enough, every fracture unites. The rate of union of a fracture is influenced by so many factors that no fixed time can be laid down. Of the cases under review in this paper, treated in Royal Air Force hospitals, despite a high proportion of multiple, severely comminuted, seriously contaminated, and infected fractures, there was not one case of non-union. The principle of complete and continuous immobilization of shaft fractures is therefore vindicated.

In order to determine the causes of slow union, 800 fractures of the shafts of the tibia and femur treated in the orthopedic centers of the Royal Air Force Medical Service and the Liverpool Royal Infirmary were investigated. Of the many local causes of slow and delayed union three were found to be outstanding in their effect: (1) interrupted immobilization; (2) infection; (3) displacement of the fragments. Many factors enter into the causes of delayed union and several tables are included illustrating relationship of time of union to various delaying factors. It was found that interrupted immobilization almost doubles the time of union and infection causes still greater delay. Of 417 fractures of the shaft of the tibia 23.7 per cent were united at the end of twelve weeks, 53.7 per cent at the end of twenty-four weeks, and 22.6 per cent after twenty-four weeks. Of fractures with infection, 65 per cent failed to unite until after twenty-four weeks, while of fractures with displacement, 68.7 per cent united only after twenty-four weeks. With continuous immobilization 95 per cent healed in less than six months and 41.7 per cent in less than twelve weeks. Fractures of the shaft of the femur unite more rapidly than tibial fractures. Of 142 fractures of the shaft of the femur 38 per cent united within twelve weeks, 45 per cent in less than twenty-four weeks, and 17.6 per cent required over 24 weeks.

Double fractures of the shaft of the tibia remote from the nutrient artery are slower to unite than the more vascular fractures near the artery. Separation of an avascular fragment and angulation of fragments with early weight-bearing are additional causes of slow union. The greater use of skeletal traction accounts for recent increase in slow union. Traction should be used to control length and not alignment. The most serious delaying factor in both closed and infected fractures is displacement and separation of fragments, the time of union in such cases being usually from six to twelve months. This factor appears to alter the quality of repair and promote fibrous tissue rather than osseous overgrowth. Rigid fixation with fragments displaced does not nullify the bad effects, regardless of the method used.

Operative reduction in skilled hands does not cause delay and it is better to prevent redisplacement of unstable fractures of the tibia by internal fixation than by continuous traction. In fractures of the shaft of the femur traction is the method of choice.

Infection is not a cause of non-union but of delayed union. Infective hyperemia may persist for many months and not until it has subsided can recalcification begin. Early excision of wounds and early sequestrectomy are important in preventing delayed union.

Chronic ulceration over the subcutaneous surface of a fractured tibia is a frequent cause of delayed union and can be avoided by prompt skin grafting.

MAX CLIMAN, M.D.

**Hemophilic Arthritis: Roentgenographic Studies in Fifteen Adult Patients with Hemophilia.** E. J. McDonald and E. L. Lozner. *Am. J. Roentgenol.* 49: 405-408, March 1943.

Two stages of hemophilic arthritis are generally recognized: (1) that of the acute hemarthrosis, either spontaneous or traumatic in origin, in which the joint is acutely distended with blood; (2) that of the chronic degenerative arthritis which may involve the joint following one or more hemarthroses. In all 15 cases studied by the authors roentgenographic changes were demonstrable in the knee on one or both sides. Similarly, the elbow was affected in all but one patient. In general, it would appear that the degree of involvement increased proportionately with the age of the patient.

Two factors are apparently concerned in the reaction of the synovial membrane: one mechanical and the other chemical. Eventually there is a tendency to fibrous ankylosis due to thickening and shortening of the joint capsule. The cartilage in most instances appears irregularly serrated due to spotty absorption and adjacent proliferation. Characteristically, the changes in the bone tissue are those of subarticular cystic absorption.

Acute hemophilic hemarthrosis simulates roentgenographically any traumatic, serous, or purulent synovitis in which the joint space is distended with fluid. Roentgenological differentiation is almost impossible at this stage. In the chronic stage differentiation must be made first from osteoarthritis. Cystic changes are much less common in osteoarthritis. Rheumatoid arthritis is more likely to involve the wrists and phalanges. Bony ankylosis may occur, also, whereas this is a distinct rarity in hemophilia. Tuberculous arthritis offers a serious challenge in differential diagnosis. It presents, however, an articular surface in which fine etching is absent and ragged and irregular scalloping is conspicuous.

CLARENCE E. WEAVER, M.D.

**Meloreostosis: Report of a Bilateral Case.** J. W. J. Carpender, D. R. Baker, S. P. Perry, and T. Outland. *Am. J. Roentgenol.* 49: 398-404, March 1943.

Cortical hyperostosis of dense sclerotic bone, either endosteal, periosteal, or both, characterizes the benign progressive lesion known as meloreostosis, which, roentgenologically, produces the effect of dripping or flowing candle wax. There is atrophy in the length of the involved bones; no expansile enlargement has been noted. The lesions, as heretofore described, involve the derivatives of the anlage of a single extremity. There is usually a history of vague, low grade pain. Shortening of the involved parts with soft tissue atrophy is almost constant. The condition must be differentiated from syphilis, tuberculosis, ossifying periostitis, and calcinosis.

The authors describe a case in which there was bilateral involvement. The lesions involved both ilia, the right femur, right tibia, and, to a lesser extent, the lateral condyle of the left femur, the left fourth and fifth metatarsals, the left cuboid and left calcaneus, and in the right foot the fourth and fifth metatarsals and lateral half of the cuboid. There were some striations

in the thoracolumbar spine. This, the authors state, is the only known case of meloreostosis with bilateral involvement.

CLARENCE E. WEAVER, M.D.

**Elevation of the First Metatarsal Bone with Hallux Equinus.** G. Hammond. *Surgery* 13: 240-256, February 1943.

An interesting deformity of the great toe and first metatarsal bone has been observed for a number of years at the University Hospital (University of Michigan). It is described as a dorsal flexion deformity of the first metatarsal and a plantar flexion deformity of the great toe.

In the early stage the deformity is not fixed. Passively, the first metatarsal assumes its normal position and the great toe can be dorsiflexed normally. Because the deformity is on the basis of muscular imbalance, the incipient stage is mainly apparent during weight-bearing and particularly walking. If the inequality of the muscle pull is not marked, the deformity may never advance beyond this stage. In many cases, however, there is a fixed deformity with subsequent development of pain over the dorsal aspects of the first metatarsal head, where a bunion may develop.

The great toe is usually in a position of flexion at the metatarsophalangeal joint. Less commonly the proximal phalanx has a flexed attitude but the distal phalanx is hyperextended. Hallux valgus may be associated. In the weight-bearing position the head of the first metatarsal is seen to be displaced upward so that the longitudinal axis of the metatarsal shaft may be horizontal or even directed anteriorly and slightly upward. A small exostosis may form on the dorsal surface of the head of the metatarsal. The first cuneiform bone may also be tilted upward. The metatarsophalangeal joint may present a subluxation if the flexed position of the phalanx is sufficient. Secondary degenerative changes may occur over the dorsal non-functioning portion of the articular surface of the metatarsal.

If the deformity becomes fixed, the metatarsophalangeal joint presents a true flexion deformity of varying degree, with the metatarsal more or less fixed in a dorsal flexed position at the metatarsocuneiform joint, or at the first cuneoscaphoid joint, or in both.

Various primary diseases are associated with this deformity. The mechanisms of production are, in the main, two in number. The first, and most frequent, is a muscular imbalance acting upon the first metatarsal, causing this bone to assume a dorsiflexed position, with secondary plantar flexion deformity of the hallux. Of the author's series of 42 cases, 86 per cent were of this type. The second mechanism is a muscular imbalance causing a plantar flexed position of the great toe, with secondary upward displacement of the first metatarsal.

In 27 cases of the series studied, anterior poliomyelitis was the underlying disease, and in 19 of these the muscular imbalance was due to tendon transplantation. The 27 cases are classified as follows; 13 cases in which there was a weak or completely paralyzed anterior tibial muscle and strong peroneal muscles with transference of the peroneus longus alone or the peroneus longus and brevis muscles to the region of insertion of the anterior tibial muscle; 8 cases in which the gastrocnemius and soleus muscles were completely paralyzed or very weak, while the anterior tibial

muscle was of normal strength; 6 cases with a strong flexor hallucis brevis muscle, the gastrocnemius-solcus muscles strong, moderately weak, or paralyzed, and the lower extremity otherwise essentially flail.

The remaining cases in the series are grouped as follows: congenital talipes equinovarus, 7 cases; osteomyelitis of the os calcis, 3 cases; cavis feet, 3 cases; pes planovalgus and paralytic pes planovalgus associated with Recklinghausen's neurofibromatosis, one case each.

In all of these conditions there had either been an injury, a surgical operation with transplantation of a single muscle or groups of muscles, or a developmental deformity resulting in a muscular imbalance of the foot. As a prophylactic measure the author advises that before transference of the peroneus longus tendon careful consideration be directed to the effect of such transference upon the first metatarsal. This tendon should not be transferred to the region of insertion of the anterior tibial tendon nor should it be transferred to the os calcis without regard for a strong anterior tibial muscle.

The treatment of the deformity, if it becomes severe enough to warrant operative correction, consists in transference of the deforming muscle, either the anterior tibial or transferred peroneus longus, to the third metatarsal base. If the deformity has existed for some time and has become more or less fixed, more radical surgery is often indicated. The deforming tendon should be transferred to the mid-foot as already suggested, and an arthrodesis of the joint or joints at which the dorsiflexion occurs should be performed, correcting the metatarsal displacement. This requires, as a rule, a corrective arthrodesis of the first metatarsocuneiform joint or the first cuneoscaphoid joint or both.

Other operative procedures have been used in correcting this deformity, inasmuch as the treatment must be individualized for each case.

J. E. WHITELEATHER, M.D.

Cortical Osteoid. A. Fchr. Schweiz. med. Wchnschr. 72: 1298-1299, Nov. 21, 1942.

The author reports a little known syndrome, characterized by pain and periosteal thickening, with a small central cortical rarefaction demonstrated roentgenographically. Frequently this latter, on pathologic study, showed osteoid structure. Conditions to be differentiated include fatigue fracture, osteomyelitis, sarcoma, and syphilis. The cause of the lesion is not clear. After chiseling off the tissue there is prompt relief of pain. In the literature this condition has been called cortical osteoid, osteoid osteoma, and tumor-like periostitis. Two illustrative cases are reported, in neither of which could osteoid tissue be recovered at operation.

LEWIS G. JACOBS, M.D.

Air Arthrography in Lesions of the Semilunar Cartilages. C. H. Cullen and G. Q. Chance. Brit. J. Surg. 30: 241-245, January 1943.

Air arthrography was employed in the examination of a series of cases in which the preliminary diagnosis was internal derangement of the knee joint. The procedure is as follows. Air is injected in the suprapatellar pouch  $\frac{1}{2}$  inch above and lateral to the patella. The amount of air varies from 70 to 140 c.c. Injection is continued until the patient feels the knee tight and there is sufficient tension to push the piston of the syringe back. A firm bandage is applied to the supra-

patellar bursa beginning from above. The joint space is localized by fluoroscopy and outlined by skin pencil to insure that the central ray passes through at exactly the right angle. The rays are directed horizontally and the part of the knee to be examined is always upward to insure maximum air filling. Non-screen films are used and tangential views are found to be of great value.

In the interpretation of the films 5 types of findings are recognized: (1) separation of cartilage from lateral ligament; (2) separation of cartilage from tibia; (3) fracture of cartilage; (4) fracture of cartilage with displacement of fragment; (5) fragmentation, reaching in cases almost complete disappearance. Fairly good illustrations of all these types are reproduced.

Of 32 cases constituting the authors' series, 22 came to operation and in 18 cases definite lesions were found. Seventeen patients would have had operation on clinical findings; the remaining 5, in all of whom definite lesions were found at operation, would probably have been rejected on these standards.

A table of operated cases is included showing correlation of the operative findings with the results of air arthrography. There was a high percentage of agreement between clinical and radiological diagnosis.

MAX CLIMAN, M.D.

## OBSTETRICS AND GYNECOLOGY

Significance of Hysterosalpingography for the Diagnosis and Treatment of Sterility. J. H. Müller. Schweiz. med. Wchnschr. 73: 204-205, Feb. 13, 1943.

The significance of hysterosalpingography in the diagnosis and treatment of sterility was investigated by analysis of 100 cases examined roentgenographically in the Zurich Womens' Clinic; 64 per cent of these patients were suffering from primary sterility, the other 36 per cent having had a previous pregnancy. The ages ranged from twenty to forty. In 46 per cent both tubes were patent; in 32 per cent there was a bilateral tubal block. Of this latter group, 18 were blocked at the lateral end bilaterally, 6 at the medial end bilaterally, and 8 in different places on the two sides. In 22 per cent there was a unilateral block. In 34 per cent of the cases the result was questionable, for one side in 23 and for both in 11. The uterus was hypoplastic in 20 per cent and showed malposition in 14 per cent. The prognosis was given as good in 34 per cent, as possibly good in 22 per cent, and as certainly bad in 35 per cent.

Follow-up is available on 84 patients, in some cases for as long as seven years. Sixty-four remained sterile; of these, 28 had been given a bad prognosis, 9 doubtful, 12 probably good, and 15 good. Twenty patients (24 per cent) became pregnant, of whom 12 had been given a good prognosis, 6 probably good, and 2 doubtful. No patient given a bad prognosis became pregnant.

The sperm of the husband could be examined in only 16 cases, and was normal in all.

In 59 cases no other therapy than the salpingography was given. Of this group, 13 became pregnant. Of 9 patients given hormones, 3 became pregnant. Of 25 operated upon for various abnormalities, only 2 became pregnant, one after a cervical dilatation and one after a unilateral adnexal resection and freeing of adhesions on the other side. Although these operative results were not brilliant, the procedure assured the patient that all possible steps had been taken to secure the desired end.

LEWIS G. JACOBS, M.D.

Direct Measurement of Caldwell-Moloy X-Ray Plates. E. A. Graber and H. I. Kantor. *Am. J. Obst. & Gynec.* 45: 112-116, January 1943.

The authors stress the importance of pelvimetry for estimating the pelvic capacity and anticipating the mechanism of labor in a majority of cases, at the same time warning that it cannot replace clinical examination and mature judgment. Paying tribute to the work of Caldwell and Moloy, they point out that many find it difficult to measure accurately the pelvic planes through the stereoscope and that variations of centimeters in readings of the same films by different obstetricians have been observed. By modifying a method originally described by Graber (*Am. J. Obst. & Gynec.* 41: 823, 1941), for application to films made by the Caldwell-Moloy technic, the authors have devised a procedure which is not dependent upon individual ocular differences.

No precision stereoscope is required. The routine method of taking Caldwell-Moloy films is followed. A metallic ruler, 18 cm. long and notched at intervals of 0.5 cm., is placed between the patient's buttocks when the lateral film is taken. The image of the metallic ruler on this film will be distorted in the same proportion as are all mid-line measurements. To measure any anteroposterior diameter, the distance between its landmarks is taken, transposed to the image of the ruler, and a true measurement is thus obtained.

To determine the transverse measurement of any plane, the distance in centimeters between its landmarks is measured directly from one of the anteroposterior (stereoscopic) views. To estimate the degree of distortion for each transverse diameter, the lateral film is again consulted. In addition to a base line drawn parallel to the film edge, just touching the outer border of the sacrum, a line is drawn from a point between the ischial spines, perpendicular to the true conjugate; another line is drawn from the mid-point between interspinous processes to the base-line; a third line is drawn between the tuberosities to the base-line. These are all similarly corrected by a direct reading from the metallic rule image.

Thus each transverse diameter provides two figures, a direct reading from the anteroposterior (stereoscopic) view and its corrected distance on the lateral view. The roentgenologist can calculate the true transverse measurement by referring to the authors' table of corrections. There are included, also, the measurements generally accepted as borderline and those indicating absolute contraction for the passage of an average size baby.

STEPHEN N. TAGER, M.D.

## THE GENITO-URINARY TRACT

Diagnosis and Treatment of Tuberculosis of the Kidney. H. L. Kretschmer. *Surg., Gynec. & Obst.* 75: 704-711, December 1942.

Since every urologist agrees with the statement that genito-urinary tuberculosis is secondary to a distant focus, it is not surprising that with the decrease in the death rate from tuberculosis in the last four decades, there has been a marked reduction in the incidence of the disease as it involves the kidney. This paper is based on a study of 95 cases of renal tuberculosis which have been under the author's personal supervision.

According to present-day belief tuberculosis of the kidney is due to infection by the hematogenous route

and the fixation of tubercle bacilli in the tissue. In view of the fact that the primary infection is usually through the respiratory tract, examination should include roentgenograms of the chest. Of 50 patients in the author's series, examined roentgenologically, one-half showed evidence of pulmonary tuberculosis, either active or healed. Of the entire series, 37 patients had evidence of tuberculosis in other parts of the body, either present at the time the patient came under observation or previously.

Diagnosis of urinary tuberculosis in the largest number of instances is easy, being based on the demonstration of pus and tubercle bacilli in the urine obtained from the kidney with the ureteral catheter. There remains the problem of localizing the lesion. A plain film of the urinary tract should be taken to rule out the presence of stone and to note the presence of calcification. Stone associated with tuberculosis is uncommon; areas of calcification are of diagnostic importance but are rarely seen and only in advanced cases.

The author believes that there is too great a tendency to rely upon the use of intravenous pyelography to the exclusion of ureteral catheterization and that one should not accept the results of intravenous pyelography alone in determining the status of the kidneys. Because of the danger of pyelogenous backflow, many urologists caution against the routine use of retrograde pyelography in the diagnosis of renal tuberculosis. The author uses this method only in cases in which examination by the intravenous method has been reported normal but examination of urine from the supposedly normal kidney discloses the presence of pus cells.

The information obtainable by cystoscopic examination and ureteral catheterization depends upon the duration of the renal tuberculosis. In early cases the bladder may be normal. In some cases changes in the ureteral orifice are seen; in others the presence of tubercles is noted in the region of the orifice. In advanced cases extensive involvement with limitation of bladder capacity is observed. Precautions should be taken against the "possibility" of infecting the normal kidney by the ureteral catheter carrying infected urine up the ureter. In this series of 95 patients, there were 25 cases in which it was not possible to catheterize the diseased side. Every attempt should be made to obtain all the necessary information at the first cystoscopic examination, as instrumentation should be kept at an absolute minimum.

Once the diagnosis of renal tuberculosis has been established, the treatment is nephrectomy. Renal tuberculosis as seen by the clinician does not heal. In the presence of bilateral tuberculosis, treatment depends largely upon the views of the individual urologist.

Hydronephrosis of a Pelvic Ectopic Kidney. H. F. Brain. *Brit. J. Surg.* 30: 191-193, January 1943.

A man aged 34 complained of pain and swelling in the lower abdomen of six to eight years' duration. The attacks occurred about once or twice a year and were followed twenty-four hours later by swelling which was progressive for four or five days. A steady retrogression then ensued, the whole cycle taking from seven to ten days. Abdominal examination revealed a smooth circular swelling, about 6½ inches in diameter, with its center just to the right of the mid-line in the hypogastrium. It was cystic in consistency and its

mobility was limited, although it could be lifted up from the pelvic brim. The urine revealed a trace of albumin and an occasional pus cell. A diagnosis of urachal cyst was made on the basis of physical examination.

When retrograde pyelography was attempted the right catheter proceeded for only about half an inch on its usual course before describing a small circle and running abruptly to the region of the left sacro-iliac joint. The abdominal mass was revealed as a large circular shadow. Excretion urography demonstrated a normal left kidney and absence of the right kidney. On the basis of these findings a diagnosis of intermittent hydronephrosis in a pelvic ectopic kidney was made.

At operation a very large hydronephrotic kidney was found in the region of the right sacro-iliac joint. The long axis of the kidney was at a right angle to the right common iliac vessels and the ureter coursing over its surface in the form of a loop, convex to the left. There were 2 pedicles, one on the medial side of the upper pole and extending to the lower end of the abdominal aorta, and the other on the lateral side of the upper pole extending downward and medially to join the com-

mon iliac vessels. This indicated that there had been a partial ascent of the kidney to a position where its blood supply was a dual one from both the common iliac vessels and abdominal aorta.

MAX CLIMAN, M.D.

## TECHNIC

**New Roentgen Apparatus for Stereoscopic Fluoroscopy: the Stereoroentgenoscope.** M. Hopf. Schweiz. med. Wchnschr. 72: 1283-1284, Nov. 14, 1942.

A description is given of the author's roentgenoscope arranged for stereoscopy. Two tubes with the foci placed at the intraocular distance are alternately energized to illuminate a fluoroscopic screen. The screen is viewed through a set of "stroboscopic spectacles" (the eyepieces are alternately blocked by a synchronous mechanism) which are fastened to the frame. The result is the effect of stereoscopic vision. Built into the spectacle assembly is a scale to allow estimate of depth of a foreign body, when such is found. The use of this apparatus in surgery is briefly discussed.

LEWIS G. JACOBS, M.D.

## ROENTGEN THERAPY

### MALIGNANT NEOPLASMS

**When Is Roentgen Therapy of Cancer Indicated and What Is to Be Expected of It?** M. Lüdin. Schweiz. med. Wchnschr. 72: 1237-1242, Nov. 7, 1942.

The first part of the question which the author puts in his title can be answered by stating that roentgen therapy is indicated whenever operation is out of the question, since only these two modalities are effective in the control of cancer. But in all operable cases (excepting skin cancer) operation should be done.

The technic of irradiation varies from case to case. The massive dose method is designed to eradicate the growth with a single blow. The so-called intensive method, giving a maximum dose in a few treatments, can be applied to some well marked out skin lesions with good results. In deep tumors the protracted fractionated method popularized by Regaud and Coutard is applicable. The last few years have seen the advent of contact irradiation, which leads to good cosmetic results.

The second part of the question—what is to be expected of irradiation?—should be carefully evaluated. The fact that a case appears hopeless should not prevent a trial of radiation where this is otherwise indicated. Postoperative irradiation may lead to surprising tumor regression, and preoperative irradiation may render operable a previously inoperable lesion. In bone metastases from mammary carcinoma palliation is especially likely to be obtained, and benefit may occur in cancer of the esophagus. Lung neoplasms are but little benefited, as a rule.

A number of illustrated case reports are included, showing regressions obtained in the author's clinic.

LEWIS G. JACOBS, M.D.

**Roentgen Therapy of Brain and Spinal Cord Tumors in Children.** F. B. Mandeville. Virginia M. Monthly 70: 86-89, February 1943.

The author has administered roentgen therapy and observed the course of 136 cases of tumor of the brain

and spinal cord. The present paper is limited to 58 cases in children under eighteen years of age.

**Astrocytoma:** This is a relatively benign and well circumscribed tumor which can be removed surgically with a low mortality rate. When completely removed it does not recur and the patient is permanently cured. Roentgen therapy is used only when removal is incomplete. Only one such case is included in the author's series, a unilateral cerebellar astrocytoma. The patient was living and well five years and eight months after operation and roentgen therapy.

**Medulloblastoma:** Thirteen medulloblastomas in children were observed. All were cerebellar; 10 patients were boys, 3 girls; 11 were white and 2 colored. One girl is living and well five years following partial removal and five series of deep x-ray treatments; 3 patients lived over four years and then showed spinal cord metastases, although in all there had been careful irradiation of the entire cerebrospinal axis. The overwhelming opinion of 15 authors was that radiation therapy should be used as an adjunct in the treatment of this type of tumor.

**Pontine Tumors:** Pontine tumors were found in 7 children, from three to ten years of age; 4 were females and 3 males; 5 were white and 2 colored. Operative and microscopic verification was usually impractical. The lack of response to radiation treatment, however, would indicate that these tumors are invariably one of three types, namely, glioblastoma multiforme, spongioblastoma polare, or resistant astrocytoma. Six of the 7 children are known to be dead, the average survival after treatment being five months.

**Craniopharyngioma:** In view of the inability of the most experienced neurosurgeons to remove these frequently partly calcified suprasellar tumors and cysts, the author believes the patients should be given the benefit of roentgen therapy. Seven cases were seen in children aged four to eighteen years. Four were males and 3 females; 5 were white and 2 colored. None was known to be dead. One white male was living six years following surgery and roentgen therapy.



**Pineal Region Tumors:** Five cases were seen in children aged two to sixteen years, 2 males and 3 females. The tumors were located in the posterior third ventricle and pineal region. One ten-year-old white boy with a verified pineal tumor lived only seven months following two series of deep roentgen therapy. Four patients with unclassified tumors of the posterior third ventricle were living when last heard of. One white boy aged ten years was living five years and three months.

The author believes roentgen therapy should be given a thorough trial in this group of tumors.

**Astroblastoma:** There were 2 cases of astroblastoma in the author's series. One patient was a boy aged four years, who was living two years and six months after partial removal of the tumor in the region of the third ventricle and three series of roentgen treatments. The other patient was an adult.

Bailey, Sosman, and Van Dessel say: "Although there is no conclusive evidence from our experience that these tumors are influenced by irradiation, we think it advisable to give a course of treatment after operation because these tumors contain fairly numerous mitotic figures and are liable to recur."

**Ependymoma:** There is a wide divergence of opinion concerning the value of irradiation in these tumors. The author treated only 2 cases in children. A white girl received five series of treatments in one year and lived six years and six days following operation. A white male, aged four years, had survived eight months when last heard from.

**Glioblastoma Multiforme:** Only one of 9 cases was in a child, a white boy aged eleven years. He lived seven months following partial extirpation and three series of deep x-ray therapy.

**Spongioblastoma Polare:** One example occurred in a white boy aged fourteen years, who had had partial excision of an occipital lobe tumor. He lived ten months following operation.

**Hemangioma:** Only one of 9 cases of hemangioma was in a child, a white girl aged four years, treated only one year ago. The adult cases have not responded in a satisfactory manner and there are very few reports in the literature favorable to irradiation in these cases.

**Unclassified Tumors:** This is an unsatisfactory group from the therapeutic standpoint. Two children were treated for cerebellar lesions which undoubtedly were medulloblastoma and had not quite reached the four-year survival period.

**Retinoblastoma:** Two cases were observed. One patient lived one year, with recurrence, following a skin dose of 5,400 r, which caused the tumor to disappear. The second patient, a four-year-old girl, had a skin dose of 5,120 r and treatment also to metastases in both femora. Both tumors responded immediately to the heavy dosage but permanent beneficial results were not expected.

**Spinal Cord Tumors:** Of 9 cases in children, 2 were unclassified gliomas. The patients were living and well, one over five and the other over four years following operation. A girl with hemangioma of the cord was alive five and a half years after operation. Two patients with unclassified gliomas have survived over one year; one with medulloblastoma of the cord is dead. In this latter case no tumor cells were found in the brain at autopsy. The remaining 3 patients, one with an ependymoma and 2 with unclassified gliomas, are living less than one year.

No cases of pituitary adenoma, sarcoma, reticulum-cell sarcoma or meningioma were observed in children. The author believes hemangioblastomas, meningiomas, and sarcomas to be radioresistant but considers treatment indicated when removal is incomplete. He does not advocate roentgen therapy for metastatic tumors of the brain, but if no primary site is found and the microscopic diagnosis is equivocal he does not hesitate to irradiate until a more adequate diagnosis is forthcoming.

J. E. WHITELEATHER, M.D.

**Million-Volt Roentgen Therapy for Intrathoracic Cancer: Palliative Effects in a Series of Sixty-three Cases.** W. L. Watson and J. Urban. *Am. J. Roentgenol.* 49: 299-306, March 1943.

While the treatment of early primary intrathoracic cancer is at present generally conceded to be surgical, roentgen therapy offers a logical form of therapy for the necessarily large group of inoperable cases. The million-volt roentgen-ray apparatus which has been in use at Memorial Hospital (New York) since 1939 delivers 52.4 r per minute (in air) at 1,000 kv. and 3 ma. at 70 cm. target-skin distance, with a filter of 2 mm. mercury, 2 mm. tungsten, and 8 mm. copper, and a half-value layer of 3.8 mm. of lead. This set-up makes it possible to deliver a large dose to a deep-seated tumor without great permanent damage to the intervening structures.

In treating cancer of the lung, two portals, each with an average area of about 150 square centimeters, one anterior and one posterior, were usually employed. Most esophageal cancers were treated through four portals, each measuring 7 by 14 cm. Each patient was examined roentgenoscopically in the position held during treatment and portals were outlined under direct vision.

Twenty-seven proved cases of carcinoma of the lung were treated. Twenty-five patients completed their outlined course of therapy and received a mean tumor dose of 4,400 r, the range being from 2,200 to 8,800 r. Symptomatic improvement of varying degree was noted in 22 cases (82 per cent) for an average duration of four months following treatment. Significant relief was indicated by a marked diminution in cough and chest pain. The survival period for the 23 deceased patients, exclusive of the 2 inadequately treated, averaged 7.3 months from the beginning of roentgen therapy.

Twenty proved cases of esophageal cancer were treated with the 1,000-kv. machine. Nineteen of the patients completed their outlined course of therapy and received a mean tumor dose of 4,000 r, with a range from 1,200 to 8,100 r. In 12 patients dysphagia was so advanced that gastrostomies were necessary for feeding purposes before roentgen therapy was instituted. Symptomatic improvement was obtained in 11 patients (55 per cent) for an average duration of five months following therapy. The survival period for the 18 deceased patients, exclusive of 1 inadequately treated, averaged 4.4 months from the beginning of roentgen therapy. One patient was well at the time of the report without evidence of residual or recurrent disease, more than thirty months after roentgen therapy was instituted.

Several patients with pulmonary metastases were given million-volt roentgen therapy, with significant resulting palliation.

The authors conclude that supervoltage roentgen

therapy will play a definite role in the palliative care of patients with cancer of the thoracic cage, but so far this study does not lend encouragement to the hope that such therapy will lead to a high percentage of five-year survivals. CLARENCE E. WEAVER, M.D.

**Bronchogenic Carcinoma: A Résumé and Some Newer Concepts.** W. S. Wallace and H. G. Jackson. *Texas State J. Med.* 38: 605-612, February 1943.

This report on bronchogenic carcinoma is based on the literature, which the authors review briefly, and a study of 28 cases from the Medical Branch of the University of Texas. The authors conclude that there is apparently an actual increase in the frequency of bronchogenic carcinoma, greater than could be explained on the basis of better diagnosis alone, and that this increase coincides with the great increase in heavy smoking, although in their own series, smoking data were available for only 10 patients and of these only 3 were heavy smokers. Mention is made of the presence of minute quantities of arsenic in tobacco smoke and the frequent occurrence of bronchogenic carcinoma among arsenic miners and it is suggested that arsenic may be an etiologic factor.

Attention is called to the palliative effect of radiation therapy, and a plea is made for its trial in every inoperable case.

**Epidermoid Carcinoma of the Anus and the Rectum.** R. B. Cattell and A. C. Williams. *Arch. Surg.* 46: 336-349, March 1943.

That the epidermoid or squamous-cell carcinomas of the anus are generally considered highly malignant and of poor prognosis the authors believe may be due to employment of inadequate forms of treatment, which fail to take into account the known pathological aspects of the disease. Ten cases seen at the Lahey Clinic are reported. Of these, 9 were anal in location and the tenth was in the rectosigmoid. These cases constituted 1.7 per cent of the 600 malignant rectal lesions seen at this clinic. Women are more often afflicted (though the authors' series included 6 men and 4 women), and the incidence is greatest in the sixth decade. The neoplasm usually arises on a basis of previous disease. There is no characteristic symptom complex; rectal pain at stool is the most common presenting complaint. In 7 of the 10 cases recorded the reported duration of symptoms was three months or less. Grossly the lesion may simulate fistula, fissure, chancre, condyloma, hemorrhoids, or other disease. It generally tends to be either warty and nodular or craterous. Histologically the tissue resembles squamous carcinoma elsewhere.

Metastasis may be by way of the lymph or blood stream. The latter route is uncommon. Lymphatic metastases are confined almost exclusively to the downward and lateral zones of spread described by Miles (*Surg., Gynec. & Obst.* 52: 350, 1931) and to the inguinal nodes. The downward zone includes the perianal skin, the sphincter ani, and the ischioanal fat. The lateral zone includes the levator ani and the coccygeal muscles, the pelvic peritoneum, the prostate, the base of the bladder, the cervix uteri, and the base of the broad ligament. Tumors below the mucocutaneous junction more often metastasize to the inguinal lymph nodes. Keyes (*Ann. Surg.* 106: 1046, 1937) reported metastases in 70 per cent of his patients.

The authors state: "Summarizing the results to

date, operation alone has been more effective than irradiation alone. These results point toward radical operation as the type of therapy offering the best prognosis." They apparently base this conclusion on a comparison of the results in their 10 cases (operated) and in 20 reported by Bensaude *et al.* (*Presse méd.* 41: 1837, 1933), treated by radon seeds and a radium proctostat. Some other series mentioned do not seem to be pertinent, as the patients were not classified as to treatment. Of Bensaude's 20 patients, 1 was alive and well for over ten years, 3 over five years, and 4 less than five years. In 4 patients regression failed to occur and the other 8 had recurrence or metastasis. Of the 10 patients comprising the authors' series, all of whom were treated by operation alone, 1 survived without disease more than ten years, 1 over five, and 4 less than five years. Three were dead, 1 postoperatively, and 1 was alive with recurrence. The authors believe that the 60 per cent loss of patients in the irradiated series as compared with the 40 per cent in this series indicates better results for a very radical operation, and that irradiation should be reserved for inoperable lesions and recurrences. They do not believe that a conservative operation is ever indicated, even in early cases, and prefer to do a radical abdominoperineal resection.

[The statistics on which these conclusions are apparently based do not bear them out. In both the above series the "five-year-cure" rate was the same, 20 per cent. While the number dead or doomed was 60 per cent for the irradiated patients and 40 per cent for those treated surgically, the standard error of the difference works out at 19 per cent, so that the difference amounts to only 1.05 standard errors. This gives a 27 per cent chance that it might have occurred as a result of the accidents of sampling alone. No analysis of the relative stages of involvement in the two series is even mentioned. Moreover, according to their own statement, the authors have had no personal experience with the use of irradiation. Whatever, the real merits of the two forms of treatment may be, it is certainly unwarranted to base such sweeping conclusions on such scant evidence. L. G. J.]

LEWIS G. JACOBS, M.D.

**End Results in Carcinoma of the Cervix and Uterus Treated with Radium.** H. Dudgeon, Jr. *Texas State J. Med.* 38: 599-602, February 1943.

This is a report of 75 cases of carcinoma of the cervix and uterus treated between 1922 and 1941. All the lesions were proved to be malignant by microscopic section. About 75 per cent were classified in groups 1 and 2 clinically.

In only 57 of the 75 cases reported were figures for five-year results available. Of 42 patients with carcinoma of the cervix, 21 remained completely well for at least five years and 21 died or were lost sight of before the five-year period expired. Fifteen of the 75 cases were carcinoma of the uterus. Eight patients in this group are dead or were lost sight of and 7 can be classified in the five-year-cure group. Eighteen patients are still under observation, having been treated since 1937. Only cases which have been free of recurrences and symptoms for five years are reported as cures.

All cases of carcinoma of the cervix were treated with radium alone, those of the uterus with radium, followed in some instances by complete hysterectomy. Fifty milligrams of radium were used, contained in



**Pineal Region Tumors:** Five cases were seen in children aged two to sixteen years, 2 males and 3 females. The tumors were located in the posterior third ventricle and pineal region. One ten-year-old white boy with a verified pineal tumor lived only seven months following two series of deep roentgen therapy. Four patients with unclassified tumors of the posterior third ventricle were living when last heard of. One white boy aged ten years was living five years and three months.

The author believes roentgen therapy should be given a thorough trial in this group of tumors.

**Astroblastoma:** There were 2 cases of astroblastoma in the author's series. One patient was a boy aged four years, who was living two years and six months after partial removal of the tumor in the region of the third ventricle and three series of roentgen treatments. The other patient was an adult.

Bailey, Sosman, and Van Dessel say: "Although there is no conclusive evidence from our experience that these tumors are influenced by irradiation, we think it advisable to give a course of treatment after operation because these tumors contain fairly numerous mitotic figures and are liable to recur."

**Ependymoma:** There is a wide divergence of opinion concerning the value of irradiation in these tumors. The author treated only 2 cases in children. A white girl received five series of treatments in one year and lived six years and six days following operation. A white male, aged four years, had survived eight months when last heard from.

**Glioblastoma Multiforme:** Only one of 9 cases was in a child, a white boy aged eleven years. He lived seven months following partial extirpation and three series of deep x-ray therapy.

**Spongioblastoma Polare:** One example occurred in a white boy aged fourteen years, who had had partial excision of an occipital lobe tumor. He lived ten months following operation.

**Hemangioma:** Only one of 9 cases of hemangioma was in a child, a white girl aged four years, treated only one year ago. The adult cases have not responded in a satisfactory manner and there are very few reports in the literature favorable to irradiation in these cases.

**Unclassified Tumors:** This is an unsatisfactory group from the therapeutic standpoint. Two children were treated for cerebellar lesions which undoubtedly were medulloblastoma and had not quite reached the four-year survival period.

**Retinoblastoma:** Two cases were observed. One patient lived one year, with recurrence, following a skin dose of 5,400 r, which caused the tumor to disappear. The second patient, a four-year-old girl, had a skin dose of 5,120 r and treatment also to metastases in both femora. Both tumors responded immediately to the heavy dosage but permanent beneficial results were not expected.

**Spinal Cord Tumors:** Of 9 cases in children, 2 were unclassified gliomas. The patients were living and well, one over five and the other over four years following operation. A girl with hemangioma of the cord was alive five and a half years after operation. Two patients with unclassified gliomas have survived over one year; one with medulloblastoma of the cord is dead. In this latter case no tumor cells were found in the brain at autopsy. The remaining 3 patients, one with an ependymoma and 2 with unclassified gliomas, are living less than one year.

No cases of pituitary adenoma, sarcoma, reticulocell sarcoma or meningioma were observed in children. The author believes hemangioblastomas, meningiomas, and sarcomas to be radioresistant but considers treatment indicated when removal is incomplete. He does not advocate roentgen therapy for metastatic tumors of the brain, but if no primary site is found and the microscopical diagnosis is equivocal he does not hesitate to irradiate until a more adequate diagnosis is forthcoming.

J. E. WHITELEATHER, M.D.

**Million-Volt Roentgen Therapy for Intrathoracic Cancer: Palliative Effects in a Series of Sixty-three Cases.** W. L. Watson and J. Urban. *Am. J. Roentgenol.* 49: 299-306, March 1943.

While the treatment of early primary intrathoracic cancer is at present generally conceded to be surgical, roentgen therapy offers a logical form of therapy for the necessarily large group of inoperable cases. The million-volt roentgen-ray apparatus which has been in use at Memorial Hospital (New York) since 1939 delivers 52.4 r per minute (in air) at 1,000 kv. and 3 ma. at 70 cm. target-skin distance, with a filter of 2 mm. mercury, 2 mm. tungsten, and 8 mm. copper, and a half-value layer of 3.8 mm. of lead. This set-up makes it possible to deliver a large dose to a deep-seated tumor without great permanent damage to the intervening structures.

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Twenty-seven proved cases of carcinoma of the lung were treated. Twenty-five patients completed their outlined course of therapy and received a mean tumor dose of 4,400 r, the range being from 2,200 to 8,800 r. Symptomatic improvement of varying degree was noted in 22 cases (82 per cent) for an average duration of four months following treatment. Significant relief was indicated by a marked diminution in cough and chest pain. The survival period for the 23 deceased patients, exclusive of the 2 inadequately treated, averaged 7.3 months from the beginning of roentgen therapy.

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Several patients with pulmonary metastases were given million-volt roentgen therapy, with significant resulting palliation.

The authors conclude that supervoltage roentgen

symptoms, in addition to abnormal vaginal bleeding, were pain in the lower abdominal region and pressure in the pelvic region.

The writers are convinced that radium is the only logical therapeutic agent in uterine bleeding not complicated by fibroids or cancer, in women in whom child-bearing need not be taken into consideration. Sixty-five patients in the series belong in this category. A complete cure was accomplished in all these.

Patients with submucous, pedunculated, or broad ligament fibroids, whether small or large, are never proper subjects for radium therapy. Radium is contraindicated, also, in patients having a history of pelvic infection or in whom pelvic adhesions due to a previous abdominal operation are present. Nor is it advisable to use radium in the presence of essential hypertension. The acute effect on ovarian function, including sudden induction of the menopause, is likely to increase the blood pressure further. The authors are not averse, however, to performing hysterectomy without removal of the ovaries in such patients.

In a group of 65 patients, radium placements at the time of plastic repair of the cervix or vaginal vault were used with excellent results.

The total dosage used for women forty years or older is 1,800 mc.-hr. of radium. The method of choice is to insert a 25-mg. applicator into the uterus, to be left there for 72 hours.

The authors' observations on morbidity, leukorrhea, bladder and rectal disturbances, menopausal symptoms, tumor involution, and menses are what one would expect. With the exception of one case, they have never encountered intra-uterine necrosis, infection, or pyometra as a result of intra-uterine radiation.

STEPHEN N. TAGER, M.D.

**Malignancy Subsequent to Irradiation of the Uterus for Benign Conditions.** L. C. Scheffey. *Am. J. Obst. & Gynec.* 44: 925-947, December 1942.

Of 481 patients with cervical carcinoma seen on the gynecologic ward service at Jefferson Medical College Hospital from 1921 to 1942, 7 had received irradiation for an apparently benign condition two to eleven years prior to the diagnosis of cancer. All 7 patients were multiparous, ranging in age from forty-two to sixty-one years. A squamous-cell carcinoma developed in each. No evidence was found that irradiation of the uterine fundus either retarded or accelerated the development of cervical cancer. The author reaffirms the importance of cervical biopsy and curettage, whenever irradiation therapy is chosen for treatment of fibromyomas, fibrosis uteri, or functional bleeding.

Of 124 patients with fundal carcinoma, 12 had received irradiation therapy for supposedly benign lesions, two to twenty-three years prior to a frank diagnosis of cancer. An additional patient similarly treated ten years earlier subsequently had a uterine sarcoma. Nine of this group of 13 were multiparous and 4 nulliparous. The ages ranged from forty-three to seventy-one years. No demonstrable relationship was found between the interval between the initial irradiation and the grade of the eventual cancer, nor between the age when the malignant growth developed and its grade. In his conclusions based on the fundal group, the author emphasizes the fact that fibromyomas should never be regarded as the sole

cause of postmenopausal bleeding, until the possibility of an accompanying adenocarcinoma of the endometrium has been eliminated.

The author uses the term "carcinoid hyperplasia" to describe an extreme grade of hyperplasia or a very low type of malignant growth, so-called papillary adenoma malignum. The stromal cells show mitotic activity; glandular structures are greatly increased in number with marked disparity in size. At times, they may present bizarre convolutions. There were 2 cases of this type in the present series in which adenocarcinoma subsequently occurred. For this reason the author now regards such changes as essentially malignant.

The author concludes that errors of omission either in technique or in judgment and not irradiation therapy were the responsible factors in the subsequent occurrence of cancer in the cases here recorded. In the absence of such errors, the retarding influence of irradiation is more or less speculative.

STEPHEN N. TAGER, M.D.

## TECHNIC

**Beam Direction in Radiotherapy.** A Symposium. F. Ellis, C. W. Wilson, J. L. Dobbie, L. G. Grimmett and A. Green. *Brit. J. Radiol.* 16: 31-43, February 1943.

F. Ellis: Having pointed out that precise application of radiation, though essential to the understanding of its biological effects, is one of the most difficult tasks in irradiation therapy, Ellis goes on to a consideration of the effects of inaccuracy in beam direction.

An error of four degrees or more, which is sufficient to be detected without the aid of angulation devices (and therefore unlikely to be made), will produce an error of centering at a depth of 10 cm. of only 0.7 cm., so that the volume treated will need to be increased only 1.2 cm. in diameter. For a distance of 50 cm. from the tube this will require increasing the surface field diameter only 1 cm. For an 8-cm. diameter field, this will increase the volume irradiated by 33 per cent.

It is necessary to know the size of the tumor, and its location. This information cannot always be obtained with any degree of accuracy. It must also be remembered that tumors may vary in position relative to the bony landmarks when the patient is in different positions. Furthermore, it is important in attempting to direct the beam accurately, to be sure that the patient does not move during treatment.

Three main types of beam direction setting are available: first, setting the tube by eye as accurately as possible; second, using mechanical devices, such as calipers, molds carrying sockets into which the applicator is set, or setting the beam by fluoroscopy with a marker in the tumor; third, the indirect method. This last consists in locating the tumor relative to various bony landmarks, marking the skin into appropriate fields, and angulating the tube so the beams will intersect at the proper place. Accurate direction may be aided by the use of arcs attached to the treatment table by which the tube may be more precisely angulated.

C. W. Wilson: The object of multiple beam therapy is to give the tumor-bearing area as homogeneous irradiation as possible, and at the same time give that area as large an amount of radiation as possible while

sparing the normal surrounding structures and skin. In many situations the intersection of the beams must take place at some point not in the tumor area to produce this result. It is necessary to plan the multiple fields with great care and apply the irradiation with equal care. Examples are given in a case of carcinoma of the larynx and a lung tumor.

*J. L. Dobbie:* The objective of treatment is to give as high a dose as possible to as small a volume as possible. This requires selecting and securing the most favorable geometrical pattern possible. Two forms of beam directors are used. A back-pointing beam director or caliper is used for the brain, whole pharynx, fauces, post-cricoid area, esophagus, and lung. The lesion is located as accurately as possible; the fields are planned, a rigid envelope is made to fit the patient, and applicator settings are fitted to the envelope. The correct direction of the beam is assured by the back-pointing caliper. The second form of director consists of a protractor and pin and arc. This is used for the bladder, prostate, rectum, cervix, and sometimes lung and esophagus. By combining the accurate setting of the area of entrance of the beam and angulation with relation to the pin and arc, which is directed toward a previously determined point, the beam may be correctly directed.

*L. G. Grimmer:* A caliper is described which is fitted with electrodes. This is applied to the patient, and when the patient moves enough to cause an error in the direction of the beam a bell is rung.

*A. Green:* Four methods of accurate directioning of the beam are described. One makes use of the point of emergence of the central ray. A right angle bar is fitted to the master cone. On the portion of the bar parallel to the central ray is a movable arm, bent in a hook shape, so that its free point indicates the central ray. Thus it is possible to determine accurately the point of emergence of the central ray. The tumor should be accurately located, and the points of entrance and emergence of the beam located for each field. The back-pointing caliper will then permit accurate setting.

The second method is called the "parallelogram method." Full understanding of this method requires reference to the illustrations. A special caliper and protractor are necessary. The method is based upon completion of the parallelogram indicated by the depth of the tumor and the angle of the central ray.

The arc method is similar to the one previously described, using an arc and a pin.

The fourth method, the "predetermined shape method," consists in determining beforehand several combinations of fields which will give a uniform dose to a

definite shape and volume of tissue. The size and location of the tumor determine which combination is to be used, and the patient is so placed that the radiation is properly received.

Devices are described for the measurement of the amount of compression and for the stabilization of the patient.

SYDNEY J. HAWLEY, M.D.

**Short Distance X-Ray Therapy with Standard Apparatus: Physical Factors.** R. S. Quick and J. E. Roberts. *Brit. J. Radiol.* 16: 82-85, March 1943.

For contact therapy the authors used special cones replacing the master cone on a shock-proof therapy tube, allowing a treatment distance of 8 cm. At 95 kv. and 2.5 ma., with a total filtration of 1.0 mm. Al, the output was 220 r per minute. The half-value layer was 1.5 mm. Al. The output is thus about midway between that of the Chaoul and Philips contact therapy tubes. The half-value layer is considerably lower. It is possible more closely to approximate the quantity and quality of the radiation from a Chaoul tube by introducing an additional copper filter.

The depth doses are of the same order as with the Chaoul tube. The use of ordinary therapy tubes adapted to contact therapy gives a somewhat higher depth dose down to 4 cm., but beyond that the greater absorption of the softer beam causes more rapid decrease than with regular contact therapy tubes.

Some conditions require a maximum depth dose at 1 to 2 cm. For such cases "middle distance" therapy can be managed by special applicators, with a focus-skin distance of about 22 cm. Shorter distances are possible but are not so convenient to use. With such cones, if a dose of 5,000 r is desired at 2 cm., a surface dose of 6,670 r is required, whereas with contact therapy a surface dose of 11,000 r is necessary.

Regular shock-proof tubes cannot be adapted for intracavity irradiation, but middle distance adaptation may be readily made.

SYDNEY J. HAWLEY, M.D.

**Materials for Depth Dose Measurement.** F. W. Spiers. *Brit. J. Radiol.* 16: 90-97, March 1943.

Various materials were studied to determine their suitability for depth dose measurements. Water remains the best medium, except for the inconveniences of its use. Powder mixtures were made, consisting of rice and sodium bicarbonate, which closely approximate water. Rice appears to be deficient in electron density and effective atomic number. Some presswoods agree reasonably well with water up to a wave length of 0.2 Ångströms.

SYDNEY J. HAWLEY, M.D.

# RADIOLOGY

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## Roentgenologic Aspects of Acute and Chronic Esophagitis<sup>1</sup>

LESTER W. PAUL, M.D.

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ESOPHAGITIS is a common complication of other diseases affecting the esophagus, such as carcinoma, diverticula, cardiospasm, and ulcer. In addition to these secondary forms and those due to the ingestion of caustics, there is a distinct group of inflammations, both acute and chronic, which may affect the esophagus and which are, in so far as the esophagus is concerned, the primary lesion in that organ. It is the purpose of this communication to review some of the features of these forms of esophagitis with particular reference to the roentgenologic aspects.

### ETIOLOGY

The frequency of esophagitis as seen at necropsy is surprisingly high. Vinson and Butt (19) found an incidence of 7.02 per cent (213 cases) in 3,032 autopsies. Bartels (1) reported finding 82 cases of acute ulcerative esophagitis in 6,000 necropsy specimens. Our own material shows a similar high frequency in general autopsy examinations, Burke (4) recording 96 cases of acute and chronic esophageal inflammation in a series of 570 necropsies. These did not include any lesions due to caustics or associated with other diseases,

such as carcinoma. Vinson and Butt emphasize the influence of vomiting and the use of the stomach tube as responsible for the increasing incidence of esophagitis. These same authors found that the esophagitis followed some form of operative procedure in 74.6 per cent of their 213 cases. In the material examined by Burke it is of interest to note that a negative suction apparatus had been used in 26 cases, frequent vomiting was a feature in 10, while in 14 a stomach tube had been passed on one or more occasions, a total of 50 cases or slightly more than half. Yet there is a striking discrepancy between this high incidence of esophagitis as found at necropsy and as seen clinically. Bartels did not believe that the use of a negative suction apparatus played much part in the causation of the inflammation in the cases reported by him and, clinically, it is extremely unusual to have significant reactions develop from its use. Wangenstein (20) stated that he had seen no ill effects from its use in over 5,000 examinations. Bartels was of the opinion that acute ulcerative esophagitis as seen at necropsy is distinctly related to vomiting or even nausea without vomiting, with relaxation of the cardiac sphincter permitting gastric juice to come into contact with the esophageal mucosa; that it seems necessary that the patient should be debilitated but not necessarily dying before changes can

<sup>1</sup> From the Department of Radiology and Physical Therapy, State of Wisconsin General Hospital, and the Medical School of the University of Wisconsin, Madison. Presented before the Radiological Society of North America at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

occur in the esophagus. These states imply a slowing of the circulation of the lower portion of the esophagus which normally is poor and therefore a loss of normal resistance of the tissues to trauma. Normally, as is known, the esophagus has a good ability to repair any area that is traumatized. While Bartels admits that there is an increasing prevalence in autopsy material he has no explanation to offer for it.

Selye (17) was able to produce a condition resembling peptic hemorrhagic esophagitis in rats by ligating the pylorus, thereby causing an accumulation of gastric juice with regurgitation into the esophagus.

Bloch (3) reported a series of cases of acute ulcerative esophagitis. He was unable to establish a definite etiologic factor but pointed out the possible relationship of vomiting and the use of the stomach tube. He also suggested that shock might play a part, since many of the lesions are found in patients dying postoperatively after serious abdominal operations. In his series there was a nearly complete absence of clinical symptoms that might be related to the esophagitis. Vomiting with blood streaking was encountered occasionally, but even in those patients with severe ulcerative lesions, obstruction with symptoms of dysphagia was not observed, and he was of the opinion that there was no way to diagnose the very acute form of esophagitis in the living, the patients being too ill, as a rule, for endoscopic examination.

Mosher (14) believed that both acute and chronic esophagitis can result from a wide variety of infections arising either within or without the esophagus. He states that infection may be carried to the esophagus from sources within the abdomen by way of the lymphatics. Thus chronic cholecystitis, chronic appendicitis, duodenal ulcer, and diseases of the liver are frequent sources of chronic esophageal infection. As causative factors for acute esophagitis he includes pneumonia, general peritonitis, infectious thrombophlebitis, and any hematogenous infection.

It is to be emphasized that most of the reports dealing with any reasonably large series of cases of esophagitis are based upon necropsy material. Clinical experience would indicate that either acute or chronic esophagitis of sufficient severity to be the cause of significant symptoms, while not rare, is unusual. Gray and Sharpe (8) state that acute esophagitis is relatively common as a transient manifestation of the damage done by ingested caustics, alcohol, or any trauma. In their experience most forms of esophagitis, excluding the agonal cases, are seen but rarely, the most common type being acute ulcerative esophagitis, the cause of which is uncertain. Chronic esophagitis, according to them, is usually only part of a syndrome of gastric disease found among persons suffering from chronic alcoholism and those addicted to eating highly seasoned and very hot foods.

Others (2, 11, 12, 18) have reported instances of acute ulcerative esophagitis following duodenal ulcer, frequently developing after operative procedures for the correction of the ulcer. The lesion seems to be the same as that found at autopsy except that the patient survives the original disease and as a result the esophagitis is likely to produce a fibrous stricture. The suggestion has been offered that many of the benign strictures found at esophagoscopy in the lower end of the esophagus are the end-results of previous esophagitis.

Chamberlin (5) noted the important relationship of peptic ulcer of the esophagus and esophageal hiatal hernia. Six of 7 patients with such an ulcer had either a short esophagus, diaphragmatic hernia, or both. This suggests a cause for patency of the cardia, usually given as one of the essentials for the production of peptic ulcer of the esophagus (the other being heterotopic gastric mucosa). A congenitally short esophagus or an acquired esophageal hiatus hernia may likewise be a factor in the development of diffuse esophagitis, and for the same reason, *i.e.*, free regurgitation of acid gastric contents into the esophagus through a patent cardia (10).

## SYMPTOMS

The most significant symptoms of esophagitis, according to Vinson and Butt, are, in the order of frequency, substernal pain, dysphagia, and hematemesis. In terminal cases Bloch found a striking absence of symptoms except for vomiting with blood streaking. In the chronic lesions, dysphagia and substernal pain are most frequently recorded. In our own clinical material, difficulty in swallowing has been the major complaint in both the acute and chronic cases.

## ROENTGENOLOGIC ASPECTS

Otell and Coe (15) report that in acute esophagitis there is no variation from the normal in the roentgen appearance; that chronic esophagitis cannot be recognized roentgenologically and can only be surmised as a possible etiologic factor in stenosing lesions of the esophagus.

Holmes and Schatzki (9) state that broadening of the rugae indicates inflammation of the esophagus. Vinson and Butt emphasize that spasm is a prominent feature but that the severity of the spasm does not appear to depend upon the degree of inflammation.

Winkelstein (21) reported a series of cases, designated by him as peptic esophagitis, which revealed striking roentgenologic findings in the form of irregular spasm and narrowing of the lower third or half of the esophagus. On esophagoscopy inflammation was seen and in all cases biopsy specimens revealed varying degrees of esophagitis. He thought the lesion was a distinct entity. At about the same time Moersch and Camp (13) reported a series of similar cases under the title "Diffuse Spasm of the Lower Part of the Esophagus." The clinical and roentgenologic appearances were the same and Moersch, in discussing Winkelstein's paper, agreed that they probably represented the same lesion. Moersch and Camp suggested the possibility of a neurogenic origin for this lesion, since many of the patients showed nervous instability. They also

suggested that chronic infection might be responsible, carried to the esophagus by the lymphatics from sources within the abdomen, as indicated by Mosher. The cause of this lesion still is unsettled.

Faulkner and associates (6, 7) reported cases of esophageal spasm which showed a definite relationship to psychic factors. Spasm, as seen through the esophagoscope, could be influenced by pleasant or unpleasant suggestions. The spasm could be increased by suggestions that called forth such emotions as grief, anger, and anxiety, and relaxed by eliciting such emotions as happiness, contentment, and elation. Whether these investigators were dealing with the same type of lesion as reported by Winkelstein and others is uncertain. In Winkelstein's cases biopsy revealed inflammation. Perhaps the spasm is the primary lesion and the chronic inflammation secondary to the long continued spasm and resulting stasis.

## REPORT OF CASES

The following cases serve to illustrate some of the clinical and roentgenologic features as observed by us:

**CASE 1: *Acute Ulcerative Esophagitis:*** A white male, 58 years of age, had had a cholecystectomy elsewhere three months prior to entering this hospital. Postoperatively he continued to have abdominal pain, vomiting, and tarry stools. Examination on admission revealed a fluctuant swelling in the region of the wound. On incision this drained bile and pus. Roentgen examination of the gastrointestinal tract demonstrated a fistula between the duodenum and the biliary passages with reflux of barium into the biliary duct system. Laparotomy confirmed the presence of a fistula between the duodenum and the gallbladder with extensive adhesions around these structures, a possible stone in the common duct, and a mass (inflammatory?) in the region of the head of the pancreas. Because of the extensive adhesions and the general condition of the patient, only a posterior gastro-enterostomy was done. Postoperatively a negative pressure tube was left in the esophagus for a week. After this was removed the patient complained of difficulty in swallowing. Roentgen examination showed diffuse spasm of the lower esophagus, loss of normal mucosal folds, a fine roughening of the margins, and considerable obstruction (Fig. 1A). These changes were interpreted as evidence of acute ulcerative esophagitis. The difficulty in swallowing increased and esophagoscopy

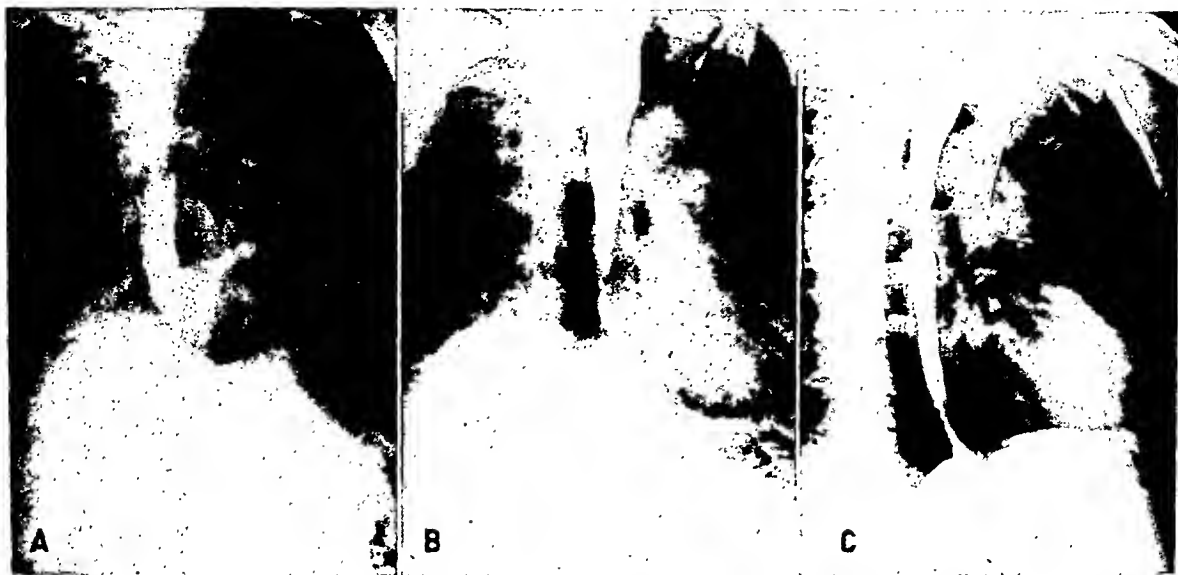


Fig. 1. Case 1: Acute ulcerative esophagitis. A. Appearance during the acute phase of the infection. The diffuse narrowing of the distal end of the esophagus was constant. No mucosal folds are apparent, and the margins show a fine roughening. B. Nine months later. The lesion has progressed to a fibrous stricture. C. Appearance three years after onset and after numerous esophageal dilatations. Patient symptomatically improved.

examination demonstrated granulation tissue and a diffuse stricture in the lower end of the esophagus (Fig. 1B). Subsequently numerous esophageal dilatations were performed and at the last examination, six years later, the patient was able to eat without difficulty (Fig. 1C).

*Comment:* This case is fairly typical of a small group in which, generally following some operative procedure on the stomach or duodenum, an acute ulcerative inflammation involving the lower part of the esophagus develops during the immediate postoperative period. In this instance a number of factors may have been responsible, including the presence of upper abdominal infection, the trauma and shock of the operation, the vomiting prior to operation and, finally, the presence of a tube in the esophagus for a period of one week following operation. The roentgen evidence consisted of severe spasm of the lower half of the esophagus, producing a uniform narrowing in caliber, a complete loss of mucosal markings, and a fine granular roughening of the surfaces indicating a diffuse ulcerative process. The lesion progressed to fibrous stricture, which was eventually relieved by repeated dilatations.

*CASE 2: Acute Ulcerative Esophagitis:* A 41-year-old white male had been operated upon elsewhere six weeks previously for a ruptured peptic ulcer. While recovering, he noticed some difficulty in swallowing. The record does not mention the use of a tube or the occurrence of vomiting postoperatively. After discharge, several weeks prior to admission to the State of Wisconsin General Hospital, the dysphagia became worse and there was some substernal pain on swallowing. Roentgen examination at the time of admission (Fig. 2) revealed the lower third of the esophagus to be diffusely narrowed, with rather pronounced delay in the passage of the meal through the involved area. No normal mucosal folds could be seen. The stomach was slightly enlarged. The duodenal bulb was deformed, with a small ulcer crater present. Esophageal dilatation was attempted but was unsuccessful. Because of increasing obstruction, evident both clinically and roentgenologically, gastrostomy was performed. Convalescence from this operation was uneventful, the patient was discharged, and has failed to return for further observation.

*Comment:* This case is similar to the previous one in that progressive lower esophageal obstruction developed during the period of convalescence following operation for a ruptured duodenal ulcer. The lesion progressed rapidly to practically complete obstruction, probably due to fibrosis, and gastrostomy was necessary. It seems probable that an acute



ulcerative esophagitis occurred postoperatively, progressing to a fibrous stricture.

**CASE 3: Chronic Esophagitis.** A 73-year-old white male had complained of difficulty in swallowing for about one year. This had become progressively worse until at the time of admission to this hospital he could swallow only liquids. There was no actual



Fig. 2. Case 2: Acute ulcerative esophagitis. Pronounced narrowing of lower half of esophagus, due in part at least to spasm. Occasionally this would relax slightly, under fluoroscopic observation, allowing some of the meal to enter the stomach. Later the deformity became completely fixed and the obstruction complete.



Fig. 3. Case 3: Chronic esophagitis with fibrous stricture of the lower esophagus, short esophagus, and esophageal hiatus hernia.

of esophageal dilatation. Following this the patient began to have fever and an increased pulse and respiratory rate. Roentgenograms of the chest demonstrated patchy consolidation at the left base and, later, the development of pleural effusion. The condition became progressively worse and death occurred three and a half weeks after admission.

At autopsy the findings with reference to the esophagus and adjacent mediastinal structures were reported as follows: "A small portion of the fundus of the stomach is herniated through the hiatus of the diaphragm (which is unusually large) and lies in the posterior mediastinum. Just above the junction of the esophagus and stomach (approximately 4 cm. above the diaphragm) there is a stricture of the esophagus by what appears to be a band of fibrous tissue in the wall. Just outside of the junction of the esophagus and stomach there is a small, fairly well walled-off abscess in the posterior mediastinum. This abscess is continuous with an empyema cavity adjacent to the left lower lobe." Microscopically the esophagus was "greatly thickened with fibrous tissue at the point of stricture. The mucosa is destroyed by chronic inflammatory reaction which extends through all layers of the wall. Old blood pigment is present in the wall. In some areas of the esophageal wall there are groups of polymor-

pain and no vomiting except for the regurgitation of swallowed food which would not pass. Esophageal dilatation had been done by the patient's physician several days prior to admission and this gave some relief. There had been a weight loss of ten pounds in six weeks. Additional complaints included serious loss of vision, deafness of the right ear, slight exertional dyspnea, and formerly a right upper quadrant pain, which had been relieved by a gallbladder type of diet. Roentgen examination of the gastrointestinal tract showed the presence of a congenitally short esophagus with an esophageal hiatus hernia; the lower third of the esophagus was diffusely narrowed; the duodenal bulb was deformed, without a visible crater. It was concluded that the patient had a benign stricture of the esophagus secondary to a chronic esophagitis (Fig. 3). Treatment consisted





Fig. 4. Case 4: Benign fibrous stricture of the esophagus.

phonuclear leucocytes." The anatomical diagnosis included (1) herniation of the fundus of the stomach through the diaphragm, (2) fibrous stricture of the esophagus, (3) acute and chronic esophagitis.

*Comment:* A review of the clinical and roentgenological data in the light of the autopsy findings suggests that this patient had a congenitally short esophagus with an esophageal hiatus hernia; that a chronic esophagitis developed, leading to a fibrous stricture, possibly as a result of regurgitation of acid gastric contents through a patent cardia. The terminal picture was one of acute periesophageal and pleural infection developing after mechanical dilatation of the esophagus.

**CASE 4: Chronic Fibrous Stricture of the Esophagus:** The patient, a white female 61 years of age, complained of inability to eat and retain fluids or solids. The difficulty had its onset three years previously and of late had been worse. There had been loss of weight and progressive weakness, but no nausea or vomiting. The clinical impression was a probable carcinoma of the esophagus. Roentgen examination (Fig. 4) demonstrated a benign stric-

ture in the lower third of the esophagus, an hour-glass type of stomach due to a large saddle ulcer on the lesser curvature of the middle third, and evidence of extensive perigastric adhesions, with the pylorus pulled up and adherent to the area of ulceration. Esophagoscopy revealed a benign stricture in the lower esophagus. The roentgen findings with reference to the stomach were confirmed at laparotomy; the adhesions were freed and the ulcer was excised.

The patient was readmitted eight months later, complaining of epigastric pain occurring intermittently with occasional nausea and vomiting. At operation a large recurrent ulcer was found. Since resection was impossible, the ulcer was closed with sutures and a posterior gastro-enterostomy was performed. The gallbladder was found to be full of stones but was not removed. Postoperatively, dysphagia developed. This was relieved by esophageal dilatation, and convalescence thereafter was uneventful.

*Comment:* In spite of the extensive gastric disease, this patient's primary complaints were referable to the esophagus. The stricture may well have been the result of previous esophagitis or ulcer, the possibility of such a process being heightened by the findings in the stomach. As shown by Mosher, the esophagus exhibits a pronounced tendency toward fibrosis when involved by infection, and a gastric ulcer may well be a source for such infection.

**CASE 5: Chronic Esophagitis or Diffuse Spasm of the Esophagus:** The patient was a female of 52 who had difficulty in swallowing of three years' duration. She had been given atropine, but with only slight relief. Esophageal dilatations had been attempted but her co-operation was poor, and they were not successful. The patient had many worries, financial and personal, and was of a nervous type. There had been a considerable weight loss, from 150 to 78 pounds. Esophagoscopy revealed a marked contraction of the lower end of the esophagus with scarring of the mucous membrane, which bled easily. There was no actual ulceration. Roentgen examination (Fig. 5) showed diffuse, intermittent spasm of the lower half of the esophagus. Another attempt at esophageal dilatation was successful, following which the patient was considerably improved.

*Comment:* This case is illustrative of the type of lesion described by Winkelstein as peptic esophagitis and by Moersch and Camp as diffuse spasm of the esophagus. Clinically, the patients often are considered as having cardiospasm, but the

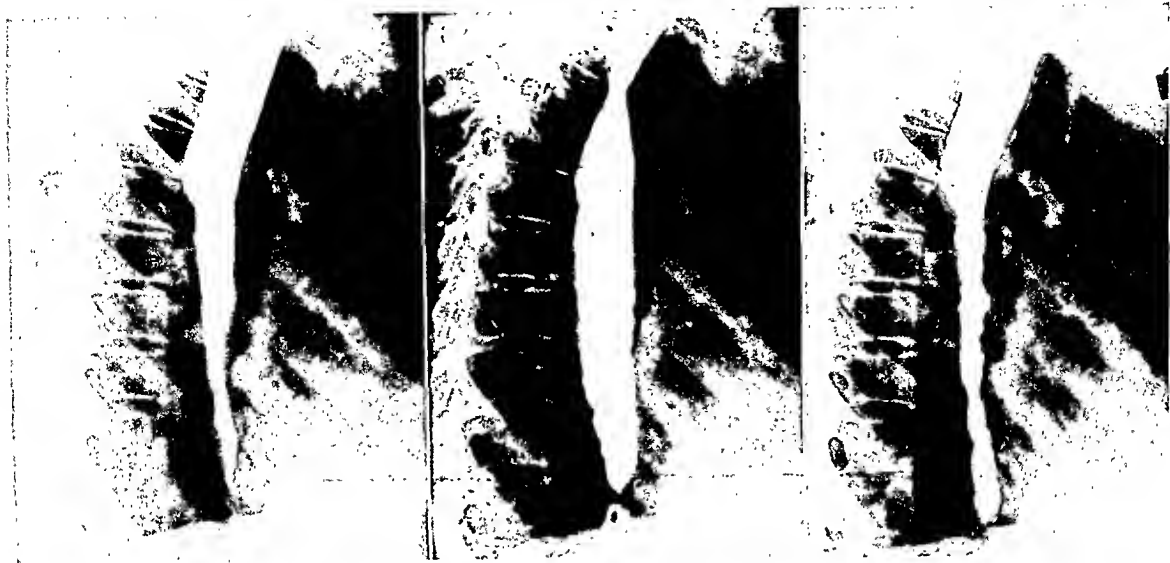


Fig. 5. Case 5: Chronic esophagitis or diffuse spasm of the lower half of the esophagus. Serial roentgenograms illustrate the rapidly changing spastic manifestations.

roentgenologic and esophagoscopic appearances are distinctly different. In our experience the lesion has been relatively uncommon, a total of seven cases having been observed during the past six years. The etiology is still a matter of conjecture, but chronic inflammation seems to be present quite uniformly.

#### DISCUSSION

From a summary of the reports in the literature and on the basis of our own experience, the following facts stand out:

(1) Acute ulcerative esophagitis is common in necropsy specimens but is unusual in clinical practice, suggesting that there must be a pronounced lowering of the resistance of the tissues before it can develop. (2) While mild forms of esophagitis may be relatively common, they are transient and seldom responsible for serious disturbance. (3) The etiology of acute ulcerative esophagitis is uncertain. A number of factors seem important, including relaxation of the cardia, permitting gastric juice to come into contact with the esophageal mucosa, frequent vomiting, and the use of the stomach tube, and the trauma and shock associated with upper abdominal operations. Since more than one or all of these factors may be present

in the individual case, it is almost impossible to determine which plays the greater part. (4) Clinically, the use of a negative suction apparatus has seldom if ever, in itself, been responsible for the production of acute esophagitis if the patient survived the disease for which he was being treated. (5) Clinical ulcerative esophagitis is seen most commonly in association with peptic ulcer, particularly duodenal ulcer, often after operative procedures for the relief of the ulcer. The lesion tends to progress to fibrosis and stricture. Benign stricture of the lower end of the esophagus without other obvious cause may often be the end-result of previous esophagitis. (6) Chronic esophagitis also is uncommon clinically. It may represent an active chronic infection or be only the fibrous residue of previous infection. (7) Diffuse spasm of the lower end of the esophagus may be a manifestation of chronic esophagitis, although the cause is not fully understood.

The roentgenologic findings in acute ulcerative esophagitis when the lesion is observed during the course of its development may be listed as follows: (1) The lesion is largely confined to the lower third or half of the esophagus. (2) The earliest evidence is that of spasm, which may be intermittent but usually is severe. (3)

Within a short time, often a matter of only several weeks, the deformity becomes fixed, probably due to fibrosis leading to diffuse narrowing, which gradually increases toward the cardia. Peristalsis is completely absent through the involved region and obstruction is pronounced. (4) There is an absence of normal mucosal folds through the contracted area, and the margins are finely irregular. (5) The lesion may progress to complete stenosis.

The roentgen differential diagnosis is not difficult. The occurrence of this lesion during the immediate postoperative period in patients who have had some type of surgical procedure for the correction of gastric or duodenal ulcer has been noted sufficiently often to suggest more than a casual relationship. The frequently associated episodes of vomiting and the use of the stomach tube or negative suction apparatus, preoperatively and postoperatively, are probably related etiologic factors. When dysphagia develops in such a patient and roentgen examination shows changes as described above, the diagnosis can be made with considerable certainty. It is obvious that the roentgen appearance will resemble closely that seen in ulcerative esophagitis following the ingestion of caustics. Chemical esophagitis is not so likely to be limited to the lower end of the esophagus, the lesion tending to be most severe at the points of anatomical narrowing and to skip other areas, producing a much more irregular stricture. The history, of course, will often be the deciding factor in establishing the etiology. The differentiation from carcinoma should be readily made. The length of the constriction and the lack of sharp demarcation from the normal wall should be sufficient to rule out cancer.

Chronic esophagitis may be only the fibrous residue of a previous acute esophagitis or may be an active chronic infection (Case 3). In the former instance, the roentgen appearances are those of a smooth constriction of variable length, without sharp demarcation at either end, located in the lower portion of the esophagus. The

lumen through the stricture is fixed and the walls are rigid. Spastic manifestations are absent. Evidence of active or healed gastric or duodenal ulceration may be elicited. In active chronic infections sufficient fibrosis may have developed so that the same type of deformity may be produced. In other instances, the most prominent feature is intermittent spastic narrowing of the lower third or half. The spasm is best demonstrated by roentgenoscopy. The rapid alterations in form are striking. At times the spasm may relax so that the lumen becomes of normal width, but this relaxation is only momentary. Normal peristalsis is not observed, but rapid up-and-down movements and, at times, a tetanic type of contraction occur. During the contraction phase, the mucosal folds appear distinctly thickened but pursue a normal longitudinal course. The presence of mucosal folds and the marked variation in the spastic phenomena during a short period of time are features which serve to distinguish this lesion from the acute ulcerative form. The duration of symptoms is likely to be longer. Esophagoscopy will confirm the presence of spasm, and areas of scarring or active inflammation may be seen. It is possible that this lesion is entirely neurogenic in origin, with the inflammatory changes secondary to chronic stasis, but since they seem to be present so frequently we have followed Winkelstein and designate it as chronic esophagitis.

#### SUMMARY AND CONCLUSIONS

1. Acute ulcerative esophagitis is a lesion frequently seen at necropsy but is rather uncommon as a clinical disease, suggesting that there must be a pronounced lowering of general resistance before it can develop.

2. Clinically, acute ulcerative esophagitis is most often associated with peptic ulcer or develops during the immediate period following upper abdominal operations. Anything which tends to cause relaxation of the cardia, permitting acid gastric juice to come into contact with the

esophageal mucosa, may predispose to its development. Frequent vomiting is an important factor. The use of a negative suction apparatus in itself is of questionable importance but may play a part when additional causes are present.

3. The roentgen changes consist of severe spasm of the distal part of the esophagus, loss of mucosal folds, and a fine roughening of surfaces. The lesion tends to progress to a fibrous stricture.

4. Chronic esophagitis of sufficient severity to be the cause of symptoms is also uncommon. If it is present for a sufficient length of time, the roentgen findings may be those of a diffuse fibrous stricture, since the esophagus shows a great tendency for the development of fibrosis when involved by infection.

5. In other instances of chronic esophagitis, the most striking roentgenologic manifestation is intermittent, diffuse spasm of the lower half or third, with thickening of the mucosal folds.

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#### DISCUSSION

Frederic E. Templeton, M.D. (Chicago, Ill.): The Society is indebted to Doctor Paul for a clear and concise picture of a lesion which has several names—acute ulcerative esophagitis, peptic esophagitis, chronic non-specific esophagitis.

There is a discrepancy between the frequency with which this lesion is seen on pathologic examination and on roentgen examination. The gastroscopist reports chronic non-specific gastritis in a much higher number of cases than does the roentgenologist, just as chronic non-specific colitis is reported in a much higher frequency by the proctoscopist than by the roentgenologist. I suggest one explanation for the discrepancy. We know that gastritis may involve only the mucosa and not the submucosa. When this happens, the condition cannot be identified roentgenologically. I believe the same thing holds true in ulcerative colitis and esophagitis.

We prefer to use only the anatomical signs for diagnosis of esophageal inflammations. These are a thickening of the mucosal folds, shallow ulceration, and stricture. We are not convinced that the spastic phenomena are diagnostic of these lesions. Physiologists have described three types of contractions of the esophagus: the primary peristaltic wave, initiated by the act of deglutition; the secondary peristaltic wave, which may arise anywhere within the esophagus; the tertiary or local contractions. The tertiary contractions, sometimes referred to as "curling," are seen in many patients past middle age. The lower half of the esophagus undergoes a diffuse, irregular, momentary type of contraction. Some authors have suggested that this form of contraction is a sign of esophagitis. Four cases which we

observed underwent postmortem examination. In none was a diffuse inflammation observed. It may be that the inflammation sets up this type of contraction, but we do not know whether or not this is incidental.

There is another reason why esophagitis is observed more frequently on pathological examination. Doctor Paul pointed out that vomiting, which washes the mucosa with acid gastric juice, probably gives rise to this lesion. Many patients in the terminal stages of disease suffer from vomiting. It may be that much of the esophagitis seen by the pathologist is a terminal process. We do not, therefore, have a chance to see this lesion roentgenologically, since roentgen examination is contraindicated.

Some European investigators have suggested that chronic, non-specific gastritis is a forerunner of gastric ulcer and carcinoma. It may be that chronic, non-specific esophagitis holds the same relationship to peptic ulcer and carcinoma of the esophagus. Perhaps we may have to revise our thinking, and look upon carcinoma and peptic ulcers of the esophagus as complications of esophagitis, rather than esopha-

gitis as a complication of peptic ulcer and carcinoma.

Lester W. Paul, M.D. (*closing*): Perhaps I should have emphasized that I do not believe that the lesion designated as peptic esophagitis or as chronic spasm of the esophagus is the same as that seen in old age, described as "curling." To me these seem to be entirely different lesions.

Chronic spasm of the esophagus or peptic esophagitis is a diffuse process and, when the contraction occurs, it does so quite uniformly throughout the length of the involved segment. While occasional concentric contractions appear, they are only momentary and the esophagus then undergoes multiple types of spastic irregularity. Curling is a phenomenon which is elicited much more commonly when the examination is done with the patient in a recumbent position and may not be seen when he is upright. The other lesions are seen regardless of the position assumed. While both may be neurogenic in origin, they do produce different roentgenologic effects.



# Roentgenological Manifestations of Pleuro-pulmonary Involvement in Tularemia<sup>1</sup>

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SINCE tularemia was first described in man by Edward Francis (1) in 1922, more than 12,000 cases have been reported. On the basis of these reports a great deal has been learned about the geographical distribution, clinical course, and symptoms of the disease. It has been found in every state of the Union and in Canada, the greatest number of cases being reported from mid-western states, especially Illinois and Missouri.

The disease is transmitted to man most often by contact with infected rabbits and other rodents, and by fowl and tick bites. It can be conveyed through the unbroken skin and eye by contact with infected material. Cases have also been recorded resulting from eating insufficiently cooked meat from infected animals. In 1933 Winter, Farrand, and Herman (2) reported a group of cases seen in the spring, during the lambing season. All were associated with the handling of sheep and with tick bites. It was thought that the unusually wet spring made handling of the animals more hazardous and that the disease in these cases was most likely due to contact with tick excreta in the wet wool.

In general the mortality of tularemia is estimated to be about 5 or 6 per cent. The mortality rate rises sharply, however, with pleuropulmonary complications. In 1924, Verbrycke (3) reported a pneumonic process in this disease. Sante (4) was the first to demonstrate pulmonary involvement roentgenographically, in 1930. Relatively little attention has been paid, however, to the pulmonary manifestations of the disease, from the roentgenologist's point of view. It is our purpose to present

the roentgenographic findings in cases with pleuropulmonary manifestations seen in a series admitted to the St. Louis City Hospital and St. Mary's Hospital, in the past five years, with a diagnosis of tularemia. This series included a total of 81 cases. The criteria for a diagnosis of tularemia were a history of contact, positive agglutination titers of 1:160 and higher or a rising titer, and recovery of the organism following guinea-pig inoculation in several isolated cases. The mortality rate for this group was 9.7 per cent. In all except one of the fatal cases, some type of pulmonary complication was confirmed by roentgenogram, autopsy, or both.

Complaints referable to the chest are frequently overlooked on account of severe local disease and the toxic state of the patient. We found that 36 of our series had symptoms referable to the chest, such as pain, cough, expectoration, and dyspnea; in only 29 of this group were chest roentgenograms made. In 2 cases, bronchopneumonic complications were recognized on roentgenograms taken routinely in patients having no physical findings characteristic of pneumonia and no chest symptoms.

The four recognized clinical forms of tularemia have been so completely described that further description is unnecessary here beyond mentioning the various types (5).

(A) The *ulcero-glandular*, which is the most common form, has a papular primary lesion which later becomes an ulcer associated with regional adenopathy.

(B) In the *glandular* type there is regional adenopathy without evidence of the primary lesion.

(C) The *oculo-glandular* type shows a primary conjunctivitis, with secondary regional adenopathy.

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.



Fig. 1. Case 1 (A. D.): Roentgenogram two day after admission, showing hilar adenopathy without parenchymal involvement.

(D) The *typhoidal* type has no primary lesion or regional adenopathy, but presents a clinical picture of profound toxicity.

Roentgenographic analysis in our series of 81 cases led to a division into two groups. The first group consisted of 72 cases of the ulcero-glandular, glandular, and oculo-glandular types; the second of 9 cases of the typhoidal type.

Of the 72 patients which composed the first group, 27 had symptoms or physical findings referable to the chest. In 19 of these there was roentgenologic evidence of pulmonary involvement, beginning with hilar adenopathy. In 14 parenchymal involvement subsequently developed; only one of this group of cases was complicated by pleural effusion. There were 2 cases without chest symptoms that showed evidence of hilar adenopathy with a patchy parenchymal involvement on roentgenograms taken routinely. In the group of 19 cases showing pleuropulmonary involvement there were 4 deaths, whereas there was but a single death from septicemia in the 53 cases which did not show pulmonary lesions.

In patients with pleuropulmonary involvement, the most consistent roentgen findings in the chest were enlarged and

nodular hilum shadows, which usually occurred early in the disease. These were often not recognized as an important entity until accentuation of the lung markings radiating to the periphery developed.

The following are illustrative cases of pleuropulmonary involvement in this first group.

CASE I: A. D., white male, 22 years old, was admitted to the City Hospital, Dec. 31, 1939. His illness began about ten days after he had dressed rabbits. Ulcers first appeared on the dorsum of the

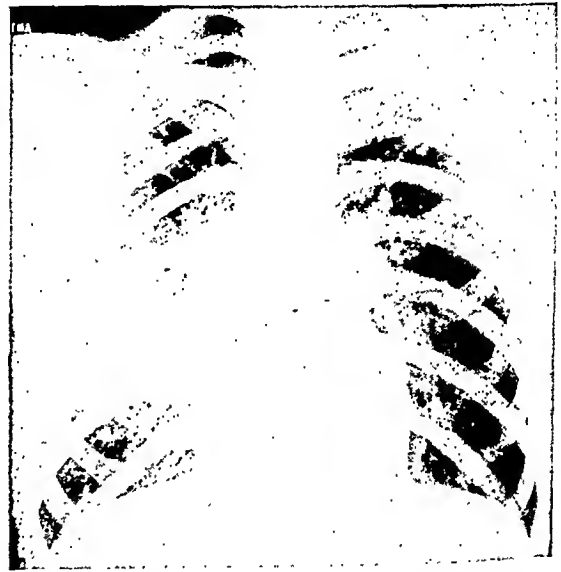


Fig. 2. Case 1 (A. D.): Examination ten day after admission reveals consolidation in the middle third of the right lung field, evidence of parenchymal extension from the hilar region.

right hand, followed later by a large swelling in the right axillary region. Several days later chills and fever developed, but the patient never complained of pain in the chest and at no time had any cough.

There was a large ulceration on the dorsum of the right hand and enlarged lymph nodes were present in the right axilla. Respirations were rapid and the temperature was elevated. Examination of the chest failed to show evidence of disease. The white blood count was 10,200; hemoglobin 98 per cent. Blood agglutination tests with *B. tularensis* were at first negative. In view of the classical picture, however, a diagnosis of tularemia was made and the patient was placed on supportive therapy.

Roentgenograms of the chest two days after admission revealed enlarged hilar lymph nodes but no evidence of parenchymatous involvement. Further roentgen examination, on the tenth day after admission, showed an area of consolidation extending from the right hilum into the right middle lobe, which

was suggestive of an atypical inflammatory process. Blood agglutination tests at this time were positive for *B. tularensis* with a titer of 1:160. On the 13th hospital day definite areas of increased density in the right middle lobe were demonstrable in posterior-anterior and right lateral views. Further examination, four days later, revealed consolidation of this lobe. Two months after admission, the area of consolidation in the right middle lobe was decreasing in size, indicating that the process was undergoing slow resolution. The patient was discharged March 4, 1940.

CASE II: B. K., male, 25 years old, was admitted Nov. 15, 1939. Ten days previously he had

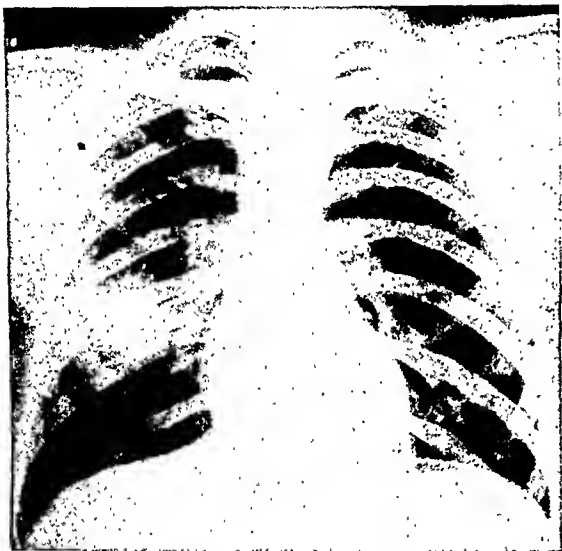


Fig. 3. Case 1 (A. D.): Re-examination one month after admission shows area of consolidation diminishing. Patient showed definite improvement.

killed a rabbit and skinned it. A week later general malaise developed, with chills and fever. These symptoms progressed until the patient became delirious four hours before admission. Two days before admission he noticed a boil at the base of the nail of his index finger and some sore lumps in the left axilla and above the elbow. On admission he was acutely ill and disoriented. The temperature was 104° F., the pulse 110, and respirations 30 per minute. In the left axilla were several large, tender, soft nodes. The epitrochlear node was greatly enlarged and the nodes in the right axilla and inguinal regions were also enlarged but less tender. The urine was normal; the white blood count on admission was 6,100. Blood agglutination with *B. tularensis* was 1:51,000.

Roentgenograms of the chest two days after admission revealed heavy hilar shadows bilaterally, with an increase in the lung markings extending outward from the hilar regions. There was, however, no evidence of infiltration or consolidation or



Fig. 4. Case 1 (A. D.): Two months after admission, roentgen examination showed consolidation on the right definitely undergoing resolution.

other sign of parenchymatous involvement in either lung. Re-examination one week later still showed heavy hilar shadows and lung markings bilaterally. The patient responded well to general supportive measures and was discharged in an improved condition on Dec. 3, 1939.

CASE III: F. P., a 54-year-old white male, was admitted to City Hospital Dec. 24, 1936, in an irrational state. About two weeks previously he had dressed a rabbit, after which an ulcer developed at the base of his right thumb. This was followed in three days by swelling and tenderness in the right axilla. Chills and fever then developed, followed by a productive cough. Four days before entrance to the hospital the patient became irrational.

The temperature on admission was 103.2° F., pulse 134, and respirations 30 per minute. The white blood count was 5,800 and blood agglutination with *B. tularensis* was 1:320. There was a small ulcer in the fold of the skin at the base of the right thumb and large and tender lymph nodes were palpable in the right axilla.

Roentgen examination of the chest the day following admission revealed an irregular consolidation in the base of the right lung. The patient did not respond to treatment and died two days after admission.

At necropsy the large palpable lymph nodes in the right axilla showed, microscopically, an area of necrosis in the center surrounded by a zone of polymorphonuclear leukocytes and lymphocytes. The lungs showed several areas of consolidation in both bases. On section, these areas were dark red in color. Microscopically the alveoli were seen to be filled with red blood cells and an inflammatory exudate. There were large areas of necrosis of the



alveolar walls and marked dilatation of the blood vessels.

CASE IV: E. M., 49-year-old white male, was admitted to St. Mary's Hospital Dec. 19, 1938, complaining of an ulcer on the middle finger of the right hand and swollen nodes in the right axilla. Approximately three weeks before admission, he had cleaned and dressed some rabbits. Shortly after this, the ulcer on the right hand had appeared, followed by swelling of the axillary lymph nodes and severe malaise and fever.

On physical examination, the patient appeared extremely toxic, cyanotic, and dyspneic. The ulcer on the right hand measured about 4 cm. in diameter and the axillary lymph nodes were greatly enlarged, discrete, soft, and tender. Chest examination revealed signs of consolidation in the right lower lobe. The white blood count on the day of admission was 13,800. Agglutination tests with *B. tularensis* were negative at this time.

Roentgenograms made on admission revealed accentuation of the hilar shadows and peribronchial infiltrations in the right base. Subsequent examination, fifteen days later, showed the inflammatory process in the right lower lobe to have spread, with associated pleural effusion. At this time, blood agglutination with *B. tularensis* was 1:200.

The patient died eighteen days after admission. About 700 c.c. of thin yellow fluid were obtained from the right pleural cavity. The right lower lobe was firm and consolidated and microscopic examination showed the alveoli to be filled with an inflammatory exudate containing polymorphonuclear leukocytes, lymphocytes, and monocytes. There were also many small areas of necrosis. The right axillary and mediastinal lymph nodes were enlarged. Microscopically they showed multiple areas of necrosis. The liver and spleen were enlarged and appeared congested. These areas also showed focal necrosis and abscess formation microscopically.

CASE V: G. M., 55-year-old white male, was admitted to St. Mary's Hospital Dec. 10, 1938, complaining of a cut on his left index finger, chills, fever, cough, and labored respiration. About fifteen days before admission, he had skinned and dressed a rabbit. After this a sore appeared on his left index finger, followed by swelling and tenderness of the left axillary nodes. Subsequently chills, fever, severe prostration, and cough developed.

Physical examination showed the patient to be in a severely toxic state, with cyanosis and dyspnea. He had an ulcer on his left index finger and greatly enlarged left axillary lymph nodes. Examination of the chest revealed signs of consolidation over the left upper lobe, confirmed roentgenographically.

The white blood count on admission was 16,000. The patient did not respond to treatment and died five days after admission.

Necropsy revealed consolidation of the left upper lobe; cut section showed severe congestion and deep red discoloration. Microscopic studies

revealed inflammatory exudate in all of the alveoli. The lymph nodes of the left axilla and mediastinum were enlarged and microscopic examination showed a coalescent type of focal necrosis.

Analysis of the roentgen findings in this group of cases shows hilar enlargement due to involvement of the tracheobronchial lymph nodes in the early stages of the disease, with later extension into the parenchyma by retrograde spread *via* the lymph channels.

In the second group, consisting of 9 cases of typhoidal tularemia, chest symptoms and roentgen evidence of hilar adenopathy were present in all. Seven of the patients had pneumonia, in one instance complicated by abscess formation. Of these 7 patients, 3 died. The most consistent roentgen findings in the chest were early parenchymal involvement, usually without enlarged hilar nodes, and later consolidation of one or more lobes with or without abscess formation.

The following cases illustrate this type of pulmonary involvement.

CASE VI: B. W., white male, aged 24 years, was admitted to the hospital Dec. 21, 1941, with chills, fever, cough, and diarrhea. The onset of his present illness dated back about twelve days. He first complained of a severe headache for several days; diarrhea then developed, and he had his first chill and fever. These symptoms lasted for several days. Three days prior to admission to the hospital a productive cough occurred with expectoration of a thick, purulent sputum and another severe chill. The patient was employed in a poultry house handling chickens and rabbits, but stated that he had used gloves constantly for protection.

On the day of admission the patient's temperature was 105° F., pulse 160, and respirations 40 per minute. He appeared acutely ill and cyanotic. No lymph nodes were palpable in the axillary or inguinal regions. There were physical signs of consolidation in the chest. The white blood count on the day of admission was 11,500, and the differential count showed a shift to the left. Sputum was examined and no pneumococci were found. Blood agglutination with *B. tularensis* was 1:160; blood cultures were negative.

A roentgenogram of the chest taken on the day of admission revealed areas of consolidation in the upper portion of the left lung and the lower portion of the middle third of the left lung. Roentgenograms one week later showed little change, if any, in these areas of consolidation. The blood ag-

glutination titer with *B. tularensis* on that same day was 1:2,560; repeated blood cultures were negative. Ten days later roentgenograms revealed regression of the consolidated areas.

While the patient stayed in the hospital he had a stormy course. Eventually, however, he recovered.

CASE VII: J. W., a 50-year-old white male, entered City Hospital Nov. 21, 1938, complaining of chills, fever, headache, and weakness for nine days. Two days after the onset of his illness a cough developed and three days later he began expectorating "prune-juice" sputum. At this time, he complained of pain in the left chest and epigastrium. One and two weeks before the onset of his illness he had contact with wild rabbits.

The patient was cyanotic and dyspneic, with a temperature of 102.8° F., pulse 116, and respirations 36 per minute.

A roentgenogram of the chest taken on admission showed haziness over the entire right side with an area of consolidation in the base of the right lung. There was evidence suggestive of cavity formation on the right side, due perhaps to beginning abscess formation. The left lung appeared clear and free from involvement. Numerous small clusters of calcification were scattered throughout both lungs and hilar regions. Blood agglutination with *B. tularensis* rose from 1:80 on Nov. 24 to 1:640 on Nov. 26. The patient was given supportive treatment and antitularemic serum. He did not respond to the treatment and continued to run a septic course. He was irrational most of the time. Death occurred Nov. 27.

At necropsy the right middle and lower lobes were found to be consolidated in their entirety. The pleural surfaces were dry and firm. These lobes cut with ease and the upper portion of the middle lobe contained a cavity measuring 1 × 2 cm. Its walls were ragged and dirty and it contained a moderate amount of necrotic material. The right upper lobe was subcrepitant, wet, and soggy. Cut sections exuded a reddish frothy fluid. The tracheobronchial lymph nodes were enlarged and some of them were calcified. Microscopic examination showed the pleura to be somewhat thickened and infiltrated with polymorphonuclear leukocytes and lymphocytes. Most of the alveoli were filled with white blood cells consisting of polymorphonuclear leukocytes, large and small lymphocytes, and many plasma cells. Numerous large and small abscesses were present. The blood vessels were engorged. The liver was enlarged (2,560 gm.) and had a typical nutmeg appearance. Microscopically it showed numerous areas of focal necrosis with a heavy infiltration of lymphocytes. The spleen was also enlarged, weighing 500 gm., with a moderate amount of lymphoid hyperplasia demonstrable microscopically.

CASE VIII: O. B., a 36-year-old white male, was admitted to City Hospital Dec. 1, 1940, com-



Fig. 5. Case IX (L. T.): Roentgen examination on day of admission reveals dense consolidation occupying the central portion of the right lung field, indicative of an acute pneumonic process.

plaining of chills and fever for five days. About ten days before the onset of his illness, he had cleaned and dressed a rabbit. Seven days later, a pharyngitis developed, which persisted for four days. This was followed by severe chills, fever, headache, nausea, and vomiting. The chills became progressively worse and on the day of admission the patient had a productive cough and pain in the right chest. The temperature was 105.8° F., pulse 100, respirations 32 per minute. The white blood cell count on admission was 16,000 and blood agglutination tests with *B. tularensis* were negative.

Roentgen examination of the chest at this time revealed heavy hilar shadows with calcified infiltration and an increase in the lung markings extending down into the right base. There was no evidence of consolidation or pleural effusion. Re-examination twenty-four hours later showed an increase in the lung markings in the right base, suggestive of an early pneumonic process. The disease continued to run a septic course and supportive treatment was given, including one transfusion of citrated blood (250 c.c.). Six days after admission the blood agglutination with *B. tularensis* was 1:160 and roentgen examination at this time showed a haziness over the right base, probably due to a pneumonic process.

The patient died the following day, and necropsy showed about 250 c.c. of a light brown fluid in the right pleural cavity. The pleural surfaces of the right lung were roughened by the deposition of small gray areas of fibrin. The lower lobe of the right lung was firm and consolidated. On its surface



Fig. 6. Case IX (L. T.): Re-examination six days after admission reveals consolidation on the right increased in size, with extension of the process into the outer portion of the left upper lobe.

also was a quadrangular area gray in color. Section through this area showed it to be of a peculiar light yellowish-gray hue, with occasional light yellowish-gray foci throughout its margin, while the rest of the parenchyma of the lobe was dark and hemorrhagic in appearance. Microscopic examination revealed a uniform consolidation in all the alveoli. There were patchy scattered foci of necrosis and the alveolar walls were indistinguishable. The nuclei of the cells were pyknotic and necrotic. Polymorphonuclear leukocytes and fibrin were seen in the alveoli. Some monocytes and plasma cells were seen in the exudate. The liver and spleen were moderately enlarged and in both small areas of necrosis were scattered throughout the parenchyma. Microscopic examination of these necrotic areas showed polymorphonuclear leukocytes, plasma cells, and monocytes.

CASE IX: L. T., a 50-year-old white male, entered City Hospital Dec. 15, 1938, in an irrational state. Eleven days earlier he began having chills and fever accompanied by cough and expectoration. Three days before admission he became delirious and grew progressively worse. He had been employed as a meat cutter for several years and three weeks before his illness had dressed rabbits on several occasions.

On physical examination the patient appeared asthenic, poorly nourished, cyanotic, and acutely ill. His temperature was 103.2°, pulse 110, and respirations 30 per minute. The white blood count taken on admission was 10,400 and agglutination with *B. tularensis* was 1:320.

Roentgen examination of the chest revealed a

dense homogeneous shadow occupying the central portion of the right lung field, indicative of an acute pneumonic process. There was also a moderate increase in peribronchial markings bilaterally. Antitularemic serum and general supportive treatment was given, including daily small blood transfusions of 250 c.c., but the patient did not improve.

Roentgen examination of the chest six days after admission to the hospital showed the area of consolidation still present in the right middle lobe and another area of consolidation in the outer portion of the middle third of the left lung field. At this time the blood agglutination with *B. tularensis* rose to 1:1,280. Death occurred five days later.

Necropsy revealed consolidation of the right lower lobe and lower portion of the left upper lobe. On section, the right lower lobe was firm and contained no air, while the consolidated area in the left upper lobe was irregularly shaped, whitish in appearance, resembling an infarct. Microscopic examination showed the alveoli to be filled with fibrin, polymorphonuclear leukocytes, lymphocytes, and plasma cells.

From a study and correlation of the roentgenographic and clinical observations in this series of cases, we believe that there are two basic types of pleuropulmonary involvement in tularemia. One manifests itself by hilar adenopathy in the earlier stages of the disease, with subsequent retrograde extension through the lymphatic channels into the parenchyma of the lung or even into the pleura with production of effusion. We observed this predominantly in the ulcero-glandular, glandular, and oculo-glandular types of tularemia. The other type involves the lung parenchyma primarily, and is usually not preceded by hilar adenopathy. The consolidations are large and homogeneous and roentgenographically resemble pneumonia. This type was found predominantly in the typhoidal type of tularemia.

There is a striking similarity clinically and pathologically between tularemia and bubonic plague (5). The glandular type of bubonic plague is by far the more common form of that disease (6), as is true also of tularemia. The pneumonic form is less common; toxicity is very severe and mortality extremely high, as is true of the typhoidal type of tularemia, which in the greater percentage of cases is complicated by pleuropulmonary involvement.

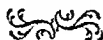
Pathologically, both of these diseases are manifested by severe necrosis and an inflammatory reaction which is not concomitant with the extent of necrosis (6, 7). It is possible that the two diseases may bear a close resemblance roentgenographically, although we were unable to find in the literature any roentgenographic comparison of bubonic plague.

Grateful acknowledgment is extended to Dr. L. R. Sante for his encouragement and assistance in preparing this paper.

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# Roentgenographic Diagnosis of Neoplasms of the Peri-Ampullary Region and Head of the Pancreas<sup>1</sup>

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**R**ADICAL EXCISION of carcinoma of the ampulla of Vater and of the head of the pancreas, together with the entire duodenum, is feasible (Diagram 1). For this reason there should be increased

operable stage, may not produce changes in the duodenal wall or contour of the duodenal curvature.

The term "ampullar carcinoma" is commonly employed to designate neoplasms of



Fig. 1. Barium fluoroscopy showing: *T*, large polypoid neoplasm (carcinoma) arising from papilla of Vater; *D*, duodenal bulb; *S*, stomach. Courtesy American Journal of Surgery.

interest in the radiographic diagnosis of neoplasms in these regions. Peri-ampullar lesions should be more readily detected than carcinomas in the head of the pancreas, since the latter, especially in the

the true ampulla as well as those arising from the papilla of Vater or immediate vicinity. Ampullar carcinomas may be polypoid and protrude into the duodenal lumen. When large, they are readily observed. Such an example is shown in Figure 1. This carcinoma was resected transduodenally, with reimplantation of bile and pancreatic ducts and the patient remains well five years later, a roentgeno-

<sup>1</sup> From the Department of Surgery and the Division of Roentgenology of the Department of Medicine, University of Chicago Clinics. Presented before the Radiological Society of North America at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

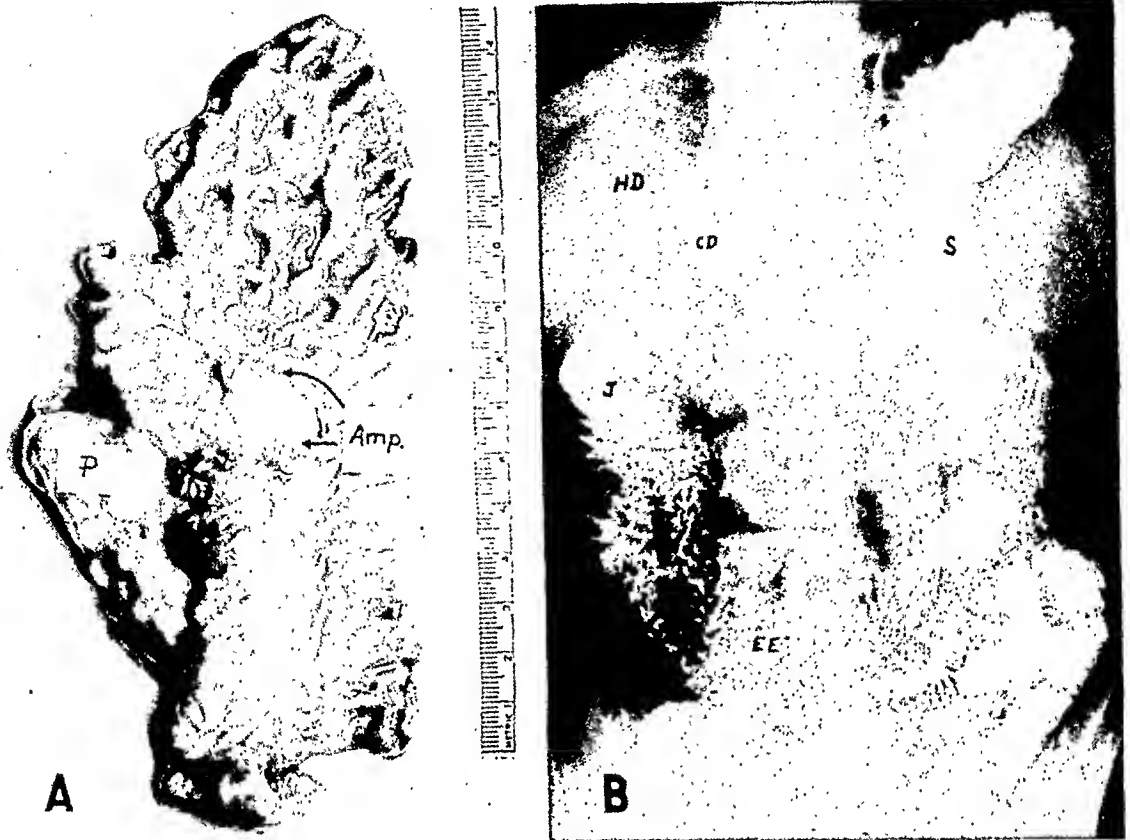


Fig. 2. A. Resected duodenum and head of pancreas (*P*) from a case of ampullar carcinoma that extended upward into the common bile duct for a distance of 2 cm. *Amp.* Enlarged papilla of Vater containing ampullar carcinoma.

B. Barium fluoroscopy three months after one-stage pancreatoduodenectomy for the lesion shown in A. *S.* Stomach. *J.* Loop of jejunum brought up for anastomosis to common bile duct (*CD*). *EE.* Site of entero-enterostomy. *HD.* Large intrahepatic bile ducts, containing barium. The entire head of the pancreas and the duodenum were excised. Patient well and at work five months after operation; regained weight lost.

gram now affording practically a normal picture of the duodenum.

A neoplasm arising within the ampulla expands the latter, affording the appearance of a smooth enlarged papilla of Vater. Theoretically this should be easily demonstrable but inability to produce marked distention of the duodenum by barium probably accounts for frequent failure of detection at fluoroscopy. The surgical specimen shown in Figure 2, consisting of the entire duodenum and the head of the pancreas, resected for ampullar carcinoma extending up the common duct, shows an enlarged and prominent papilla which was not discovered on fluoroscopy. A roentgenogram made three months after operation, as depicted in Diagram 1, shows the disposition of barium in the altered upper alimentary tract (Fig. 2B).

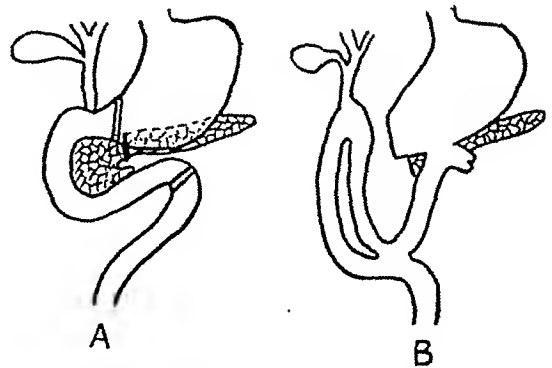


Diagram 1. Schematic representation of one-stage pancreatoduodenectomy, excision of entire duodenum and head of pancreas, for carcinoma of head of pancreas or ampulla. A. Showing lines of transection through lower portion of stomach, neck of pancreas, and at duodenojejunal junction or slightly beyond. B. Restitution of continuity by gastrojejunostomy, choledochojejunostomy (or cholecystojejunostomy), and entero-enterostomy, to facilitate passage of material down the bowel without passing by biliary-alimentary tract anastomosis.



Fig. 3. A. Resected duodenum, head of pancreas, and lower portion of stomach (S) from case of oval ulcerating carcinoma (C) replacing papilla of Vater. N. Metastatic node resected from porta hepatis. M. Solitary visible metastasis in liver, also resected. Patient progressed satisfactorily after operation but died on twelfth postoperative day of uremia. Necropsy revealed no hemorrhage or peritonitis.

B. Roentgenogram of duodenum depicted in A, showing deformity (C) and rigidity of convex margin of second portion of duodenum produced by flat ulcerating ampullar carcinoma.

Ampullar carcinomas may also afford flattened ulcerations with raised rolled edges (Fig. 3A). These may produce consistent irregularities in outline of the duodenal wall accentuated by a stiffness of the involved segment (Fig. 3B).

Extensive infiltration of the duodenal wall by ampullar carcinoma, or carcinoma primary in the second portion of the duodenum, causes great distortion of the wall and rigidity of the involved segment, and should be easily detected. In these cases, also, normal mucosal markings are replaced by irregular coarse markings and there may be polypoid masses protruding into the lumen. Even in the presence of such evidence of advanced carcinoma resection may well be possible.

Frostberg's "reversed 3" (E) sign is indicative of edema of the papilla secondary

to a neoplasm in the vicinity or to a neoplasm actually within the ampulla. When present it is of great significance, but its absence does not signify that a neoplasm can be ruled out. Figure 4A illustrates this sign in a graphic manner. Some months previously, in another institution, this patient had had a cholecystostomy, which drained persistently. Following admission to the University of Chicago Clinics, injection of iodized oil into the cholecystostomy in conjunction with barium fluoroscopy of the duodenum afforded the picture reproduced here. After transduodenal resection and reimplantation of the ducts, with cholecystogastrostomy, the patient has remained well three and one-half years. It should be pointed out that prominent folds in the duodenum seen in profile may be confused with a "reverse



3" sign. In a true "reverse 3 sign," however, the "lips" are broader than would be true of prominent folds and, furthermore, constancy in the location of the deformity in the presence of peristalsis and palpation is the outstanding and important feature.

Again, all of the criteria for ampullar carcinoma may be present and yet no neoplasm be found, as occurred in the case illustrated in Figure 5. The patient gave a history of painless jaundice for six weeks and it was thought that a distended gallbladder was palpated. Roentgenograms showed an atypical "reversed 3" sign—atypical in that it did not protrude into the lumen. Compression of the second portion of the duodenum produced a rounded indentation, in the center of which was a fleck of barium. This was interpreted as an enlarged papilla with dilated ampulla, the latter receiving the barium. Operation revealed a cirrhotic liver, and an abnormal protuberance downward from the right lobe was found to be the structure palpated before operation and thought to be the gallbladder. Actually the gallbladder was not distended.

As mentioned above, carcinoma of the head of the pancreas is now also amenable to radical resection. However, small tumors within the head of the pancreas usually will not afford evidence of duodenal distortion. Indeed, such small operable carcinomas should not be expected to yield roentgenographic signs of their presence.

Small carcinomas arising in the periphery of the head of the pancreas may invade the duodenal wall and produce areas of rigidity or actual ulcerations which may be accompanied by stenosis and obstruction of the duodenum. In one such patient operated upon by one of us (A. B.) the clinical picture was that of a pyloric obstruction with severe gastric dilatation resulting from invasion and stenosis of the first part of the duodenum by a small carcinoma in the upper portion of the head of the pancreas. A large carcinoma replacing the head of the pancreas may show a minimum of distortion in the duodenum or may

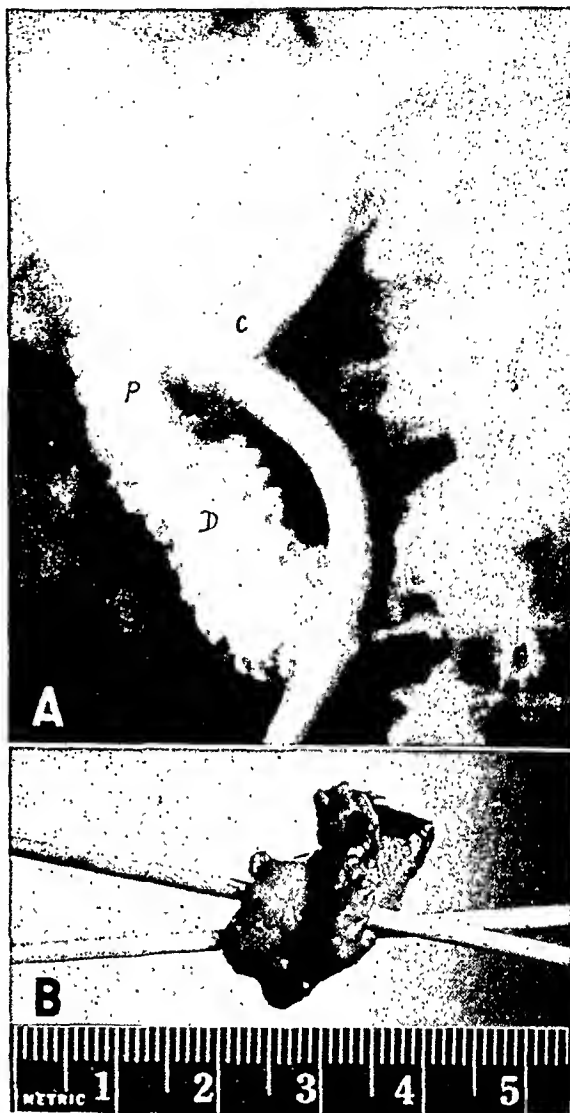


Fig. 4. A. "Reverse-3" sign in patient who had previous cholecystostomy; tube in cholecystostomy for injection of iodized oil. C. Common duct, showing arrest of injected oil by neoplasm in ampulla. D. Duodenum filled with barium. P. Protruding deformity (with reverse-3 contour) in duodenum, due to edematous papilla of Vater containing an ampullar carcinoma.

B. Resected papilla of Vater, shown roentgenographically in A, containing ampullar carcinoma protruding into duodenal lumen above patent bile and pancreatic ducts, into which wooden probes have been inserted. The resected lesion does not appear as large as it did *in vivo* because there was considerable edema. Small lesions such as this are treated by transduodenal resection and reimplantation of bile ducts and pancreatic ducts.

produce no alteration in the duodenal contour. The surgical specimen shown in Figure 6, consisting of the lower pylorus, entire duodenum, 3 cm. of jejunum, and the head, neck, and a portion of the body



of the pancreas with carcinoma was excised from a patient in whom roentgenologic evidence of cancer of the head of the pancreas was not detectable. Marked widen-

extensive neoplasm, exploratory operation should be performed.

It thus appears that roentgenographic examination may afford clear-cut evidence

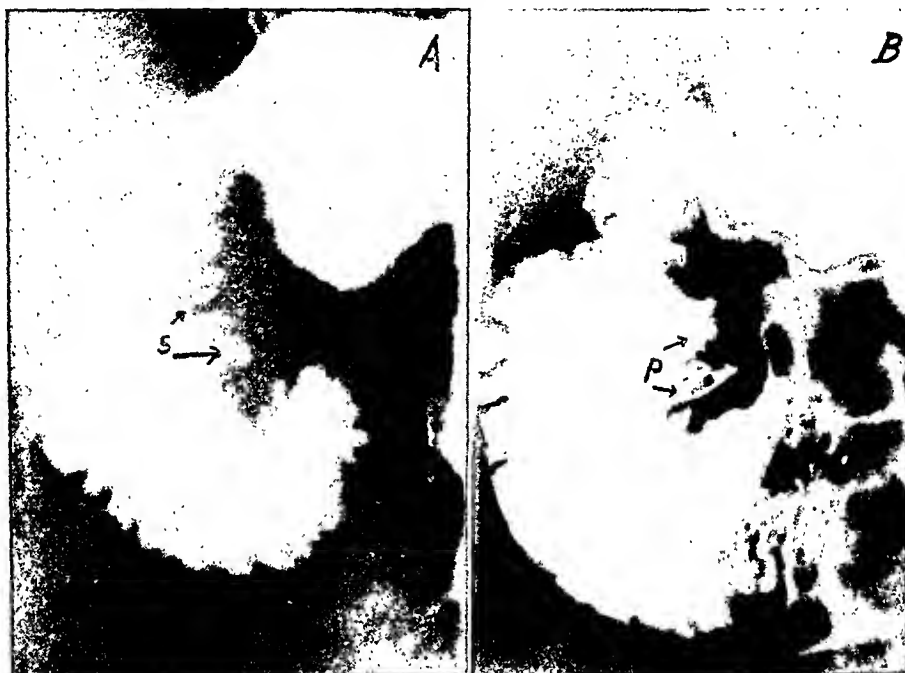


Fig. 5. A. Barium fluoroscopy of duodenum in patient with icterus and with what was thought to be a palpable gallbladder. S. "Atypical" reverse-3 sign. While the reverse-3 configuration is present, it appears to be a diverticulum rather than an indentation into the lumen.

B. Compression of the duodenum afforded the impression of an enlarged papilla of Vater (P) with barium entering the ampulla. At operation, no neoplasm was found, and icterus proved the result of diffuse cholangitis. The papilla of Vater was normal on direct visualization.

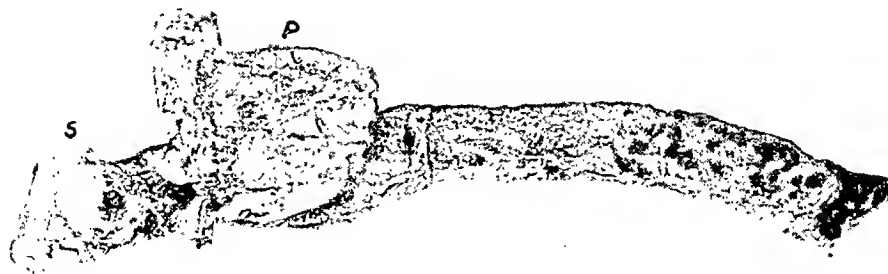


Fig. 6. Resected head and neck of pancreas, P; lower portion of stomach, S; and entire duodenum. The carcinoma caused enlargement of the head of the pancreas but was not detected at fluoroscopy.

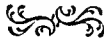
ing of the duodenal curve, when present, ordinarily indicates an advanced neoplasm of the head of the pancreas. It is the opinion of the writers, however, that regardless of roentgenographic evidence of

of the presence of an ampullar carcinoma or carcinoma of the head of the pancreas. On the other hand, such lesions may be of appreciable size, still operable, and yet afford no roentgen evidence of their pres-

ence. In the diagnosis of such lesions the clinical picture of obstructive icterus, unassociated with typical gallstone colic, possibly accompanied by an enlarged, distended and palpable gallbladder (Courvoisier's sign) is the most important indication for exploratory laparotomy. Persistent epigastric pain or upper abdominal pain, often deep boring in character and radiating through the body to the back, is suggestive of carcinoma of the head of the pancreas, whereas, obstructive jaundice accompanied by some pain at the onset and later "painless" is more indicative of

ampullar carcinoma. Exploratory laparotomy should not be postponed because of lack of roentgenologic evidence of neoplasm in the ampulla or in the head of the pancreas. Nor should it be refused because of roentgen evidence of extensive duodenal involvement, since resection of even large tumors in this region may afford some degree of palliation for those patients whose average length of life in the absence of treatment is but six to eight months from the onset of symptoms.

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# Non-Organic Gastric Filling Defects Simulating Carcinoma<sup>1</sup>

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THE MAJORITY of benign and malignant gastric tumors are located in the pars pylorica of the stomach and reveal their presence roentgenologically as prepyloric deformities. Gastric spasm and extragastric lesions may produce such deformities. The differential diagnostic features of these defects have frequently been described. In a recent paper on gastric cancer, B. R. Kirklin (4) summarized the roentgenological findings usually considered as the pathognomonic syndrome of advanced mucoid carcinoma: a gross filling defect projecting from a wide base far into the gastric lumen; an irregular internal margin; sharp demarcation from the uninvolved portion; and, as a rule, little or no alteration in the size of the stomach. These features may be associated with physical signs and secondary manifestations, namely, a palpable mass; fixation of the stomach; destruction, effacement, or smoothing of the gastric rugae; absence of peristalsis from the affected portion, and rapid emptying time unless obstruction is present.

Kirklin includes gastrosplasm and various extrinsic conditions among lesions to be differentiated from carcinoma and states that the deformity produced by carcinoma is persistent as to site and configuration, withstands manipulation, and remains unchanged at subsequent examinations, while distortions caused by simulants have none of these qualities.

We are presenting the history, the roentgenologic, operative, and pathologic findings in two patients in whom a diagnosis of gastric carcinoma was made, based on most of the diagnostic features listed above. In both instances our diagnosis was incorrect.



Fig. 1. Case 1: Film showing filling defect, with involvement of rugae, after administration of atropine (Jan. 2, 1942). Note the similarity to Figure 2.

CASE 1: R. C., a male, age 51, was admitted to St. Luke's Hospital, Dec. 29, 1941. He complained of pain, varying from dull to intense, in the upper abdomen, epigastric distress following meals, occasional vomiting, and failure to get the relief alkaline powders had previously given him. His first gastric symptoms dated back one year, at which time he first experienced epigastric discomfort, bloating, and belching. Except for recurrences of similar dyspepsia within six months and again a few days prior to his admission, he had felt quite well, showing no lassitude, loss of weight, or weakness. Five days prior to admission, Dr. James T. Case had made a complete roentgenologic study of the patient's gastro-intestinal tract. A diagnosis of organic lesion of the pylorus was made, the exact nature of which was not stated. The lesion was thought, however, to be due to an inflammatory process.

Physical examination was negative except for a mild dyspnea. Laboratory findings of note were as follows: hemoglobin 15.1 gm.; R.B.C. 5,090,000; gastric contents, free HCl 56°, total acid 68°; two blood Kahn tests negative. Five stool examina-

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

tions were negative for blood and amoebae. Total N.P.N., blood sugar, blood calcium, and cholesterol were within normal limits. The sedimentation rate was within normal limits. A chest film and Graham-Cole study of the gallbladder showed no abnormalities. The electrocardiograph showed nothing of importance.

On Jan. 2, 1942, we made a careful roentgenologic examination of the gastro-intestinal tract. The patient was given 1/100 grain of atropine sulfate

scopic examination offered no additional information, as the pylorus could not be seen satisfactorily. The body of the stomach was smooth and the mucosa normal. Projections beyond the angularis on the lesser curvature were thought to be thickened folds.

At operation the stomach and duodenum appeared externally normal. Nothing was found in the nature of indurations, nodules, or glands in the stomach. The gallbladder, liver, and surrounding

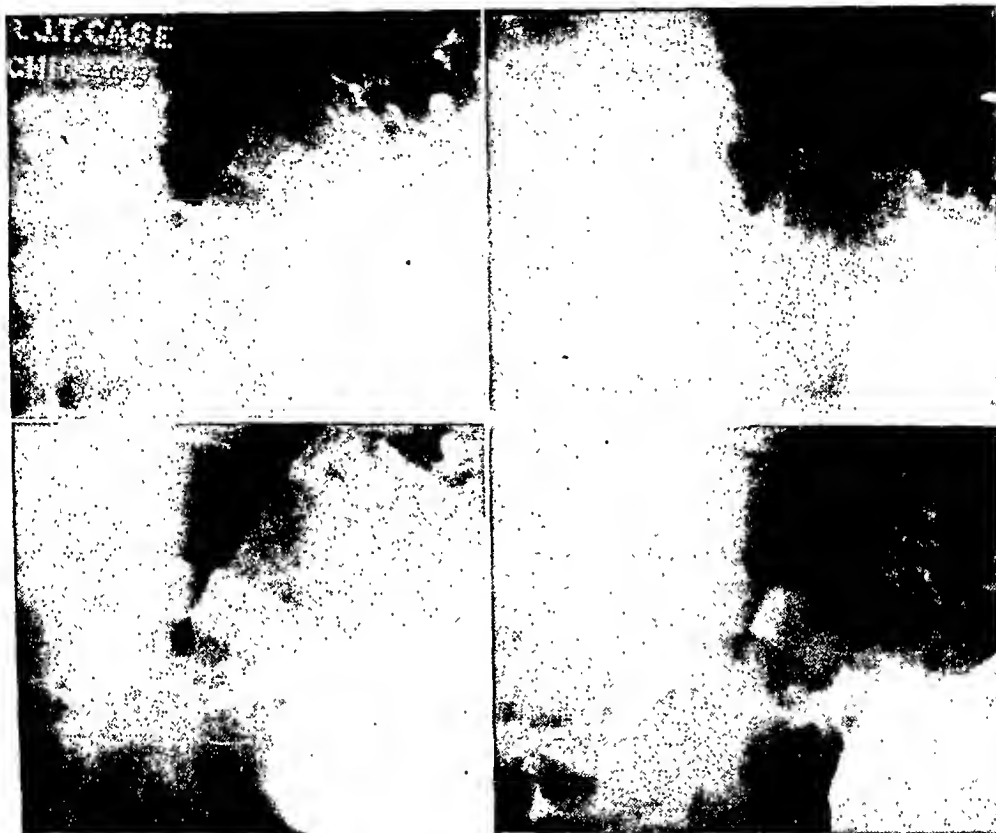


Fig. 2. Case 1: Original film (Doctor Case), showing filling defect in pyloric antrum and involvement of rugae.

by mouth, twenty-four, twelve, and two hours prior to the examination. Eight minims of tincture of belladonna were administered six hours before examination. The stomach showed a large, well circumscribed filling defect involving the walls of the pars pylorica. There was no large intraluminal mass. The lines of demarcation were rather sharp and the rugae irregular. In the pars cardica and pars media the rugae appeared distorted and thickened. Fluoroscopically, the pyloric defect was constant, and the peristaltic waves did not traverse the area. Comparison of our films (Fig. 1) with those of Dr. Case (Fig. 2) leaves no doubt as to the constancy of the lesion. The duodenal bulb was normal. The roentgen diagnosis was "filling defect involving the pars pylorica, which should be considered malignant until proved otherwise." Gastro-

regions were normal to inspection and palpation. In view of the roentgen findings, an incision was made one inch above the pylorus on the anterior wall of the stomach. A small section of mucosa, muscularis, and serosa, was removed for gross and microscopic study. The lining of the stomach and first part of the duodenum were inspected, palpated, and found normal. Microscopic examination of the biopsy specimen showed normal gastric tissue and no evidence of disease (Dr. E. F. Hirsch).

Dr. S. W. McArthur's observations during the operative procedure are extremely interesting in view of the roentgen findings. Palpation of the pylorus and antrum gave him a definite impression of induration in the entire region. After a short pause, with the region still between the thumb and index finger, this impression vanished entirely.

On further palpation and visual inspection, he observed an extraordinary spasm involving the stomach when first touched, followed by relaxation, with normal consistency to palpation. During the entire operative procedure any traction on the stomach or palpation of the splenic area produced a profound regional gastrospasm with prompt cessation of respiration.

In view of the profound gastric spasm exhibited by this patient under general anesthesia, it is reasonable to suppose that the antispasmodics given prior to the second roentgen examination had little or no effect.

parietal lesions. Stone and Ruggles (6) believe it advisable to administer atropine or belladonna until the throat is dry in order to relax gastrospasm and pylorospasm.

Amyl nitrite was tried by us but was discontinued due to the frequent fainting of the patients at the time of examination. Mecholyl, physostigmine, and calcium gluconate have also been tried, but are not advised for routine use. The antispasmodic action of drugs is a result of their

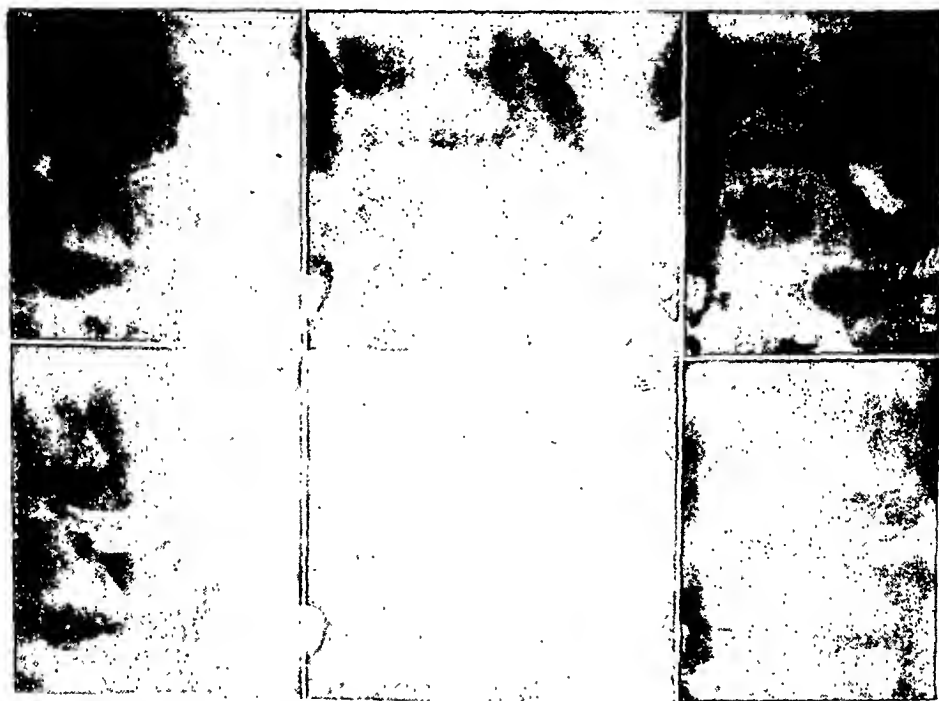


Fig. 3. Case 2: Film showing filling defect and distortion and partial destruction of the rugae (Aug. 5, 1940). These findings were constant during fluoroscopic examination.

Objections have been raised to the use of atropine and belladonna as antispasmodics. Ritvo (5) found atropine ineffective in gastrospasm and recommended 20 to 30 mg. of benzedrine sulfate orally in suspected gastrospasm and pylorospasm. Cerqua (2) showed that large doses of atropine in dogs produced spasm of both the pylorus and fundus. On the other hand, more frequent use of atropine and belladonna has been advised in a recent paper by Bernard and Monnier (1). They regard it as an aid in differentiating spasm from ulcer, perigastritis, neoplasms, and

effect upon the extrinsic nerve supply of the stomach which supplies the outer longitudinal and inner circular muscular layers. Vagus stimulation activates the stomach, whereas sympathetic stimulation relaxes it. According to the theory advanced by Forssell (3), the gastric mucosa can adapt its rugae, in response to the stimulus of food, as a local autonomic response, not dependent upon the distant nerve control. Gastrospasm is usually thought of as intrinsic, due to gastric pathology, or extragastric, due to reflex or other stimulation of the extrinsic nerves.

Since no pathological condition could be demonstrated in our case, we feel that the changes were due to local autonomic response.

A similar case, presenting the possibility of muscular mucosal spasm was examined by us in 1940.

CASE 2: E. H., a male, age 48, complained of distress and bloating after eating. His appetite was poor, but eating, lying down, or belching relieved the distress for a short time. He often experienced faintness and nausea, but there was no

examinations. The stomach was hyperactive, but the filling defect was clearly demarcated. The pylorus was spastic and allowed no barium to pass through for about fifteen minutes. Re-examination was advised after administration of an antispasmodic and was done two days later after atropinization to physiological limits. The pyloric antrum was again found narrowed and spastic. In some of the films the rugae appeared normal, and the possibility of a hypertrophic pylorus with spasm was considered. Re-examination was again advised after medical management. Approximately one month later, on Sept. 10, 1940, the stomach was re-examined with a barium meal. The pyloric antrum

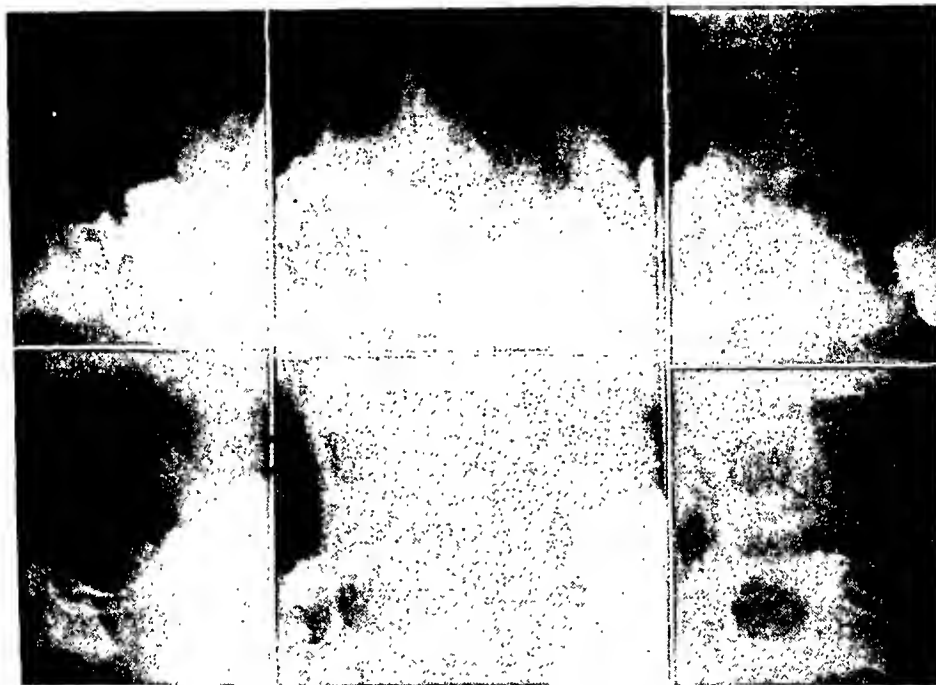


Fig. 4. Case 2: Persistence of filling defect after medical management and administration of antispasmodics (Sept. 10, 1940).

history of vomiting. The bowel movements were regular and the stools normal. The history was negative except for the fact that the patient had been working very hard (fourteen to fifteen hours a day). The physical examination was negative. The laboratory findings were as follows: hemoglobin 90 per cent (Sahli); R.B.C. 5,360,000; W.B.C., differential count, and sedimentation rate normal. The urinalysis, Wassermann, and Kahn tests were negative. There were no other significant findings.

Roentgen examination of the stomach by means of a barium meal on Aug. 5, 1940 (Fig. 3) revealed a definite narrowing of the pyloric antrum for a distance of 3 cm. The rugae appeared distorted and partially destroyed. The filling defect was constant during the fluoroscopic and serialographic

was again narrowed (Fig. 4) as before. The peristaltic waves extended downward to the pars pylorica, then ended abruptly. The roentgen diagnosis was "organic filling defect, probably malignant, but hypertrophy of the rugae and pyloric muscle must be considered."

At operation it was Dr. G. V. Pontius' impression that the pylorus was thickened. The stomach was opened and the mucosa revealed hypertrophic rugae, but no definite mass could be distinguished. There was no evidence of enlarged lymph nodes. A partial resection was decided upon and the distal fourth of the stomach was removed. A gastrojejunal anastomosis was done. The pathological report was as follows: "No rugae or pyloric hypertrophy could be seen in the resected portion of the stomach and duodenum. Microscopically, serial sections of the

entire resected portion revealed no invasive epithelial growth or inflammatory process" (Dr. E. F. Hirsch).

As in the first case, the surgeon may have felt and seen a gastric spasm which he interpreted as pyloric and rugal hypertrophy. On the basis of Forssell's work (3), such a spasm may be postulated as involving the muscularis mucosa. Atropine would not be expected to relieve such a spasm. On Jan. 29, 1942, approximately one year after the gastric resection, we again examined E. H. The stoma at the site of the anastomosis seemed to function perfectly. The remaining portion of the stomach was found to be normal, except for prominent gastric rugae.

We have recently examined several patients fluoroscopically immediately after intravenous administration of 1/75 gr. of atropine. The changes occurring in the stomach are prompt and definite. The peristaltic waves, active prior to the administration of the drug, are absent a very few minutes thereafter. The stomach becomes relaxed and appears flaccid. There is a pronounced increase in the cardiac rate immediately following the administration of the drug. There have been no untoward reactions in the few cases we have observed. The intravenous administration of atropine may, in selected cases, be more efficacious than the oral or intramuscular method. It is impossible, however, at this time to state categorically whether this procedure is useful and safe.

The intravenous administration of atropine for the control of spasticity is by no means new. Dr. James T. Case did a considerable amount of work with atropine intravenously a number of years ago. Very little on the subject is found, however, in the literature.

#### COMMENTS

The lesions described in this paper were not of the medullary type. We were unable to identify an intraluminal mass in either case. The changes appeared to be quite superficial, and only the walls of the stomach seemed to be involved. Both curvatures of the pyloric antrum were ir-

regular and the area was sharply demarcated. Peristaltic waves were absent in the affected area. Palpation gave one the impression of rigidity with loss of pliability. The contracted antrum could not be expanded by palpation, even when using force. Although a negative pathological report was rendered in these two cases, we are of the opinion that careful re-examination should be made at rather frequent intervals.

At present we must accept the pathologist's report. Perhaps in time the apparent spasm may prove to be an early manifestation of something more serious, which will shortly become evident. It is not unusual to encounter spasm as the first symptom in carcinoma of the esophagus.

The gastric manifestations, both fluoroscopically and roentgenographically, are not those of a normal stomach. Spasm, of course, may be due to an overstimulated autonomic nervous system. The deformity caused by spasm is usually smooth. Vitamin deficiency also has been given as a cause for spasm.

The lowered vitality of the tissues may serve as a fertile ground for the development of an infection or an inflammatory process. This hypothesis, however, is not substantiated by the pathological report, as there was no evidence of an inflammatory process.

#### SUMMARY

1. It is our opinion that large constant deformities of the pars pylorica may be due to spasm not associated with organic disease. Atropine and belladonna had no effect in relaxing the spasm in the cases presented.

2. The presence of a constant gastric deformity does not always mean carcinoma, nor does it preclude the possibility of spasm as the cause of the deformity.

3. Filling defects due to intraluminal tumors are not difficult to differentiate. Deformities involving only the walls of the stomach, even though present at several examinations and resistant to antispasmodics, may be due to spasm.

4. The old concept that spasm of the pyloric antrum appears smooth and narrow fluoroscopically and roentgenographically is not borne out by the facts presented in the reported cases.

5. Further investigation is necessary regarding antispasmodics. A drug which could be depended upon to relax the stomach at all times would be of immense aid in differentiating gastric lesions.

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#### DISCUSSION

James T. Case, M.D. (Chicago, Ill.): I wish to pay my respects to the authors for their courage in reporting cases of this sort. I am sure all of us have experienced the chagrin of having our opinions contradicted by the surgical findings.

I recall one case of this sort in which I reported a lesion exactly similar to the ones described by Doctor Jenkinson, where the gastroscopist failed to see any sign of an organic lesion in the pyloric end of the stomach and my diagnosis of carcinoma was discredited. One year later, however, to the day, the patient returned to the gastroscopist for a further examination, without going through the x-ray department, and this time there was discovered an inoperable carcinoma of the stomach. One must conclude that a stomach with a persisting prepyloric deformity, even though this is thought to be spastic, must be considered a potential host of ulcer or carcinoma.

Another occurrence which may lead to a similar filling defect in the pyloric region is gastrogastic invagination—that is, invagination of the prepyloric end of the stomach, including the duodenum and

distal end of the stomach, back into the stomach. This would give the same kind of filling defect as has been reported by a few authors. In my personal work I have had no proved case of gastrogastic invagination, but I believe we should be on the lookout for it and recognize it when we see it.

I am afraid if I had to examine again the patient of mine whose case Dr. Jenkinson reported, with the same findings as before, I would make the same diagnosis—an organic lesion of the stomach.

J. R. Maxfield, Jr., M.D. (Dallas, Texas): Doctor Jenkinson's excellent presentation has been of unusual interest to me, since I have recently had a case that parallels his in many ways.

A colored female came to the X-ray Department with a prepyloric defect similar to those he has described. This defect was constant on three fluoroscopic examinations, in spite of the use of antispasmodics. A gastroscopic examination was done by Doctor Patterson of Dallas and he reported "no organic lesion found." Since the patient had a positive Wassermann reaction, it was assumed that the lesion was syphilitic in origin. Despite adequate antisyphilitic therapy, however, subsequent fluoroscopic examinations showed persistence of the defect. Operation was then decided upon. When gross examination of the stomach revealed no pathological condition and there was nothing palpable, the radiologist was called to the operating table. The possibility of closing the incision without opening the stomach was discussed but at the insistence of the radiologist it was decided that the stomach should be looked into. A small incision was made and on the posterior wall of the stomach was a small mass, 2 to 3 mm. in diameter. It was obviously, however, not the defect reported on fluoroscopic examination. This mass bled when wiped with a suction tip. It was removed for biopsy and the pathological report was papillary adenoma (gastric polyp).

This patient has been examined fluoroscopically several times since operation, and the defect in the stomach is still present. She has gained weight, going from 90 to 130 pounds. She is still on antisyphilitic treatment. The last examination still showed the defect in the lower portion of the stomach, about an inch and a half prepyloric, with the same appearance as at the first examination.

Sherwood Moore, M.D. (St. Louis, Mo.): I would like to ask Doctor Jenkinson about the Wassermann reaction in his patients and whether or not there was a history of syphilis.

Samuel Brown, M.D. (Cincinnati, Ohio): I have been very much interested in Doctor Jenkinson's paper and illustrations. In a number of cases I have encountered similar abnormal shadows which were difficult to differentiate from those produced by true gastric tumors. Re-examination after administration of an antispasmodic often helps to remove any doubt as to the nature of the abnormal shadows.



Frederic E. Templeton, M.D. (Chicago, Ill.): We have seen a number of lesions such as Doctor Jenkinson described. We have followed several of these cases for long periods of time and in all we have at some time or other encountered an ulcer on the vertical portion of the lesser curvature. The narrowed antra which accompanied these ulcers persisted after the ulcers healed. These narrowed antra also complicated the medical treatment of the ulcer by causing considerable retention.

At gastroscopy some of these antra appeared normal. Microscopic study after gastric resection indicated the existence of inflammation in some and abnormal changes in others.

In one of Doctor Jenkinson's slides I thought I could see an ulcer on the lesser curvature about 4 or 5 cm. above the narrowing. Did the long range history suggest ulcer in any of these cases?

Edward L. Jenkinson, M.D. (closing): Answering Doctor Moore's question, in both our patients the Wassermann and Kahn reactions were negative. The patients had no history of syphilis.

Regarding Doctor Templeton's discussion, I felt as he did. I thought perhaps the patient might have an ulcer. The symptoms were not very definite, but I pointed out that there was an ulcer, and, further than that, the surgeon removed the area. In the second case, which showed a deformity, the whole pyloric portion of the stomach was resected. The pathologist, of course, is the court of last resort. He did serial sections on both of these cases and found no lesion in either. Irrespective of what the pathologist says, however, these are not normal stomachs. If they are, we had better change our ideas of what a normal stomach looks like.

Possibly I should not have shown these cases at this time. I have been trying to get the first patient back for re-examination, but unfortunately I have not been able to do so. I believe these patients should be examined further. I am not satisfied and feel that there may eventually develop a lesion that can be proved by sections. All I can say now is what we thought. We were apparently wrong, in view of what the pathologist reported.

# Observations on Venography of the Lower Extremities<sup>1</sup>

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THE OBSERVATIONS on venography of the lower extremities recorded in this paper have been made from a series of approximately 130 cases and cover a period of a year. Interest in the subject was stimulated by reports of cases of acute thrombophlebitis by Fine and Sears and by Homans and Dougherty, but the work was undertaken without any preconceived ideas obtained from the literature. Bauer's fine monograph was not seen until several months later. Acute thrombophlebitis is not as yet thoroughly investigated in most places. The aid to be obtained from venographic procedures both for diagnosis and as an indication for treatment is not sufficiently appreciated. Many of our cases were investigated because of chronic conditions involving the legs.

Since a number of our observations are dependent upon technical factors, a brief report of the manner in which the work was done will be given. It is our belief that adequate roentgen examination involving physiological processes cannot be made with a single film. Physiological changes in many parts of the body are rapid and somewhat variable. The ideal method for the study of such processes would be by moving pictures if this were technically feasible. Photo-roentgen devices may make such studies possible, but these are still out of the question for most of us.

The next best procedure seems to be a serial method, consisting in multiple film studies made over varying time intervals. The passage of dye through the venous and arterial circulation is rapid. In our own experience, the interpretation of single films is tricky and frequently misleading. Fortunately, in the lower extremity, with the patient supine, the dye passes through the venous circulation slowly enough to be

demonstrated in multiple exposures from the region of the ankle to the thigh and including the first portion of the external iliac vein. This will be brought out more fully later.

For our studies we have used diodrast, the patient being given the Dolan mouth test prior to injection. Twenty cubic centimeters of the dye are injected slowly over a period of approximately two minutes through a very small needle into a small vein on the dorsum of the foot or below the internal or external malleolus. In our experience, it has only occasionally been necessary to cut down on a vein for injection of the dye—in cases with such severe edema or swelling of the foot and ankle that it was not possible otherwise to find a vein.

In our first serial method we utilized a device which we already had, which allowed the division of a 14 × 17-inch film for three exposures. This worked fairly well for the small leg and the region of the knee. For the bulky or adipose extremity with varicose veins and for the circulation of the thigh and groin, it was difficult to position the patient so that the full venous circulation could be demonstrated. In recent months, we have been using two lead screens, one on either side of the top of the Bucky table, of sufficient width so that the intervening space allows a coverage of half a 14 × 17-inch film. These lead screens are long enough to reach from the ankle to the lower abdomen. Between them the extremity can be satisfactorily positioned so that the entire venous circulation of the leg, thigh, and lower pelvis can be portrayed on serial films.

During the two minutes of injection, six exposures are made. The first two are made from the region of the ankle upward after about 4 to 5 c.c. of dye has been injected. As soon as the tube stand and Bucky tray can be shifted upward, two

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

more exposures are made of the upper leg and knee and lower thigh. Again, the tube stand and Bucky are shifted upward and the last two exposures are made, including the upper thigh and lower pelvis. These exposures are in pairs and each is made from a stereoscopic position. We realize that any part must be absolutely still for a proper stereoscopic view. The dye remains long enough in one place, however, to allow us to differentiate between the deep and superficial circulation. This has proved to be very important and is one of the difficult problems in a single-film examination. By rapid work, it is possible to complete six exposures while the dye is being injected. Occasionally, a fourth film is made with two exposures, one on either half of the film, after the conclusion of the injection. Usually, this film is made of the upper leg and knee area.

By this procedure, we obtain a series of overlapping films of the region from the ankle up to and including the lower pelvis. The time interval between these films is such that in the normal case visualization of the venous structures of leg and thigh into which the dye enters is obtained. The fourth film gives us added information about the upward passage of the dye in the upper portion of the extremity. The stereoscopic films enable us to reconstruct anatomical positions with considerable certainty.

A review of the anatomy as disclosed in studies of normal and pathological material is in order. For this purpose it seems simpler to describe venous structures in their order from above downward. The uppermost part of the venous tree which is demonstrable is the external iliac vein. Frequently, this can be seen for a distance of several inches before the dye becomes too diluted with blood from other parts of the body so that the contour is lost. In the region of the femoral fossa, immediately below Poupart's ligament, there is normally a large valve where the internal or greater saphenous empties into the femoral vein. This, in our experience, has been very constant. Below the junction of the

femoral with the internal saphenous there are frequently several valves, about two inches apart. The femoral vein proceeds downward approximately in the region of the femoral artery. It winds around the inside of the thigh slightly away from the femur and continues down the inner portion of the thigh toward the popliteal fossa. This vein frequently divides into two or three parts. These divisions are more frequently seen in the lower half of its course, but usually recombine before the popliteal fossa is reached.

At the upper portion of the popliteal fossa, the femoral vein, which is here normally seen as one large vein, becomes the popliteal vein. This latter vein is extremely variable. It usually breaks up into two or three main trunks, which follow the divisions of the popliteal artery. It may divide in the upper portion or in the middle of the popliteal fossa or, occasionally, lower down, in the upper leg. The two main divisions usually seen are the anterior and posterior tibial veins. The third division is the peroneal vein. Frequently, this appears to have its origin below the division of the popliteal into the two tibial veins, coming off the posterior tibial. This latter vein may divide into two parts. These three deep veins proceed downward fairly close to the interosseous space between the tibia and fibula, almost to the region of the ankle, before being lost as individual trunks.

Two other main venous trunks, found rather constantly, should be mentioned: the internal and external saphenous veins. The *internal saphenous* or greater saphenous starts at the femoral fossa and proceeds downward in the superficial tissues along the inner portion of the thigh to the region of the knee. Usually, this vein is demonstrable as a main trunk almost to the ankle. Coming off from the internal saphenous in the middle and lower thirds of the thigh are several deep communicating veins which pass inward to the femoral vein. These veins have been seen frequently in normal material and very frequently in pathological conditions. Below

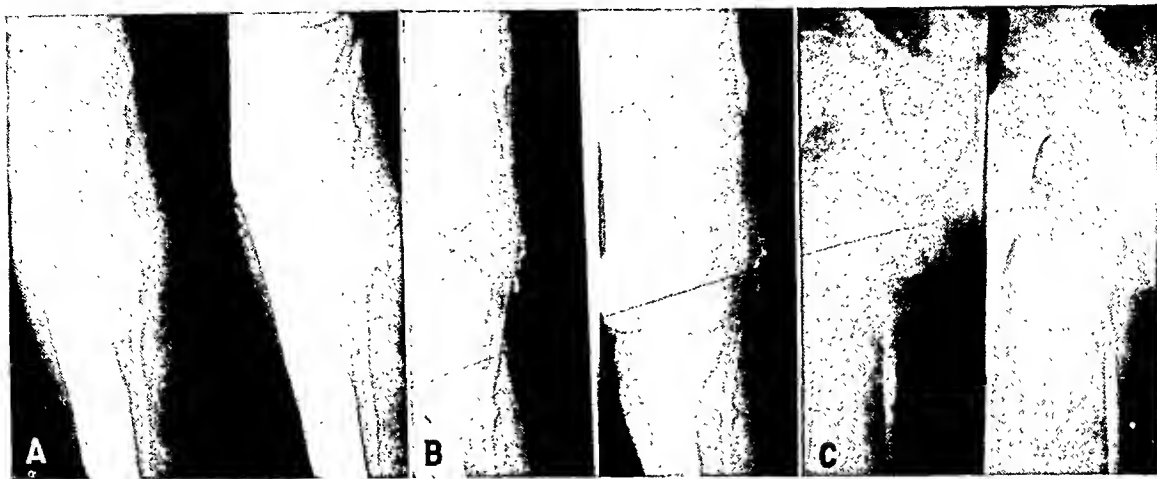


Fig. 1. Block of deep circulation. The three films, representing six exposures, constitute a serial set. The dye goes up through the internal saphenous and on into the iliac in the region of the femoral fossa. In A and B, retrograde extension of the dye can be seen into two veins overlying the lower portion of the femur. This retrograde extension is through valves. These veins are dilated.

the knee the internal saphenous frequently breaks up into many trunks which anastomose freely with the superficial circulation.

The *external saphenous* vein is usually seen as a main trunk from the region of the ankle upward to the knee. It is commonly held that this vein dips inward slightly above the knee and joins the popliteal vein in the upper portion of the popliteal space. We have, however, observed this very few times. In most of our material, both normal and pathological, the external saphenous breaks into a plexus of veins at the knee, or above or below it. This plexus of veins passes posteriorly through the superficial tissues and empties into the internal saphenous either close to the knee or above it.

Occasionally, a connection of the internal saphenous also empties into the popliteal vein. Sometimes, a superficial vein runs directly upward in the posterior part of the leg. On a single anteroposterior film this may be confused with a deep vein. The superficial veins that have been visualized lie largely in the leg and around the knee. They have been seen as a considerable plexus freely communicating with one another and with deep communicating veins lying largely in the internal, posterior, and lateral aspects of the leg. The veins in the anterior portion of the leg have been

visualized only in pathological cases. In the region of the ankle and from the ankle upward to the knee, the deep communicating veins connecting with the superficial plexus overlying the inner, posterior, and lateral portions of the leg, are frequent and many. These deep communicating veins are usually rather short. Venae comites or paired veins have rarely been observed. The number of valves has been variable.

By the use of serial films, we believe that observations can be made which can properly be called physiological. In an endeavor to have a base line on which to form our conclusions, a number of normal subjects have been examined in the manner described above. Patients referred for intravenous urography were given the dye in a small vein in the region of the ankle, or below, and studies were made of the venous structures of the leg prior to the making of the urograms. These persons had no history of past or present trouble in the extremities.

From a physiological point of view, the point of injection of the dye makes surprisingly little difference as to the manner in which it traverses the venous structures of the leg. If the injection is made under the external malleolus, slightly more of the dye appears to pass up the external



Fig. 2. Deep block of leg and lower thigh. The dye is passing up through the superficial circulation to the mid portion of the thigh. At this point, most of the dye goes inward through communicating veins and upward through the femoral vein. The deep circulation is blocked in the leg and lower half of the thigh.

venous branches and the external saphenous is more likely to be seen. If a vein on the dorsum of the foot is chosen, the dye spreads in both directions laterally and internally and then goes around into the posterior veins. If the dye is injected over the internal malleolus, more of it tends to pass up over the inner and the posterior surface of the leg. In normal subjects, immediately following injection the bulk of the dye seeks the deep communicating veins in the lower part of the leg and enters the deep circulation fairly close to the ankle. A small percentage spreads through the superficial circulation, and the superficial venous structures up to the knee are usually demonstrable. As a rule, the internal or greater saphenous vein is well shown regardless of the point of injection. The fact should be emphasized that in the normal person, lying supine,

most of the dye injected in the region of the ankle appears to enter the deep circulation directly and pass upward through this channel. A smaller amount of dye travels directly upward through anastomosing channels in the superficial circulation. Progress of the dye is steadily upward unless disease is present. The dye in the superficial vessels may swing inward through deep communicating veins to the deeper structures.

The time element involved in the spreading of the dye from one area to another is important both from the standpoint of obtaining satisfactory films and, to some extent, from the standpoint of interpretation. On the basis of numerous serial films taken at varying intervals of time, a few generalizations can be made. Within ten to fifteen seconds after the injection is started, the dye has spread to the superficial veins in the ankle region and has started to enter the deep circulation, usually in the lower third of the leg. In the usual case the dye which enters the deep circulation goes upward somewhat more quickly than that which remains in the superficial veins. At approximately thirty to forty-five seconds, the deep veins in the lower leg will normally be well filled and the lower femoral will usually show good filling. Frequently the dye passes up the internal saphenous vein to approximately the same level as seen in the deep veins in thirty to forty-five seconds. In the remainder of the superficial plexuses of the leg the dye usually goes upward somewhat more slowly and a number of the superficial veins of the knee may not be demonstrable for a minute to a minute and a half. Above the knee, progress is rapid through the popliteal and femoral vein. By this time the dye is becoming somewhat diluted, and unless films in this area are made during the injection, visualization is usually incomplete or entirely lacking. The optimum time for taking the film of the upper thigh appears to be, approximately, from forty-five seconds to a minute and a half after the injection is begun and while it is still going on.

In a number of normal subjects we have found the dye to remain in the deep veins and some of the superficial veins of the legs as long as five minutes or slightly longer. This, however, occurs only if the patient has been perfectly still and has not moved during this period, of time. Motion of the leg or muscle contraction appears to force the dye upward. This observation gives rise to speculation concerning postoperative thrombosis. Does



Fig. 3. Typical example of deep block of the leg. The dye travels up through the superficial circulation to the region of the knee. There a portion passes inward to the femoral or popliteal and thence upward in the femoral. The other portion of the dye goes upward through the superficial circulation.

the prolonged inactivity of the legs on a relatively hard table, while the patient is anesthetized, cause prolonged stagnation of venous blood? Such slowing of the venous stream combined with a very minor bruise would certainly set the stage for a thrombophlebitis.

In younger persons, with extremely straight veins, the dye passes upward more quickly than in older subjects with slightly tortuous or dilated veins. Normally the dye does not remain in the veins of the



Fig. 4. Superficial block in the upper half of the leg. The dye passes up through the superficial plexus to the mid leg and thence inward to the deep circulation, as it is abruptly blocked in the superficial circulation. This is the appearance of a subacute superficial phlebitis.

thigh in sufficient concentration to allow visualization for a longer time than about a minute.

We have seen one case in which the dye took a retrograde course through two valves into a communicating vein extending from the middle of the internal saphenous in the thigh. There was no evidence of block above this point or of dilatation or disease in either the internal saphenous or this connecting vein.

In pathological material, also, certain physiological observations have been made. The passage of the dye upward is definitely retarded in the presence of severe varicosities and in veins that are dilated and tortuous. Where the vein is blocked above the point where the dye is visualized, its upward passage may, of course, be delayed. In one case of early pregnancy we were not able to observe any delay in the upward passage of the dye, while in a case of late



Fig. 5. Block of superficial circulation in the mid leg. The dye goes up through the superficial and deep circulation to the mid leg. At this point, all of the dye passes inward to the deep circulation. This is the typical appearance of an acute superficial phlebitis.

pregnancy there was a very definite delay. The dye may remain in varicose veins for a considerably longer time than in normal veins.

A few cases have been seen in which a small portion of the deep circulation has been blocked by thrombosis or spasm. In these cases the dye passes upward through the deep circulation to the point of obstruction and then returns to the superficial circulation through connecting veins. Having continued upward to the region above the block, it again passes inward through the communicating veins to the deep circulation. Where a block occurs in the superficial circulation, because of phlebitis, the dye may turn backward by means of deep communicating veins to other superficial veins or into the deep circulation. In other words, it passes around a block in either the deep or the

superficial circulation with surprising ease. As mentioned before, anastomoses between the deep and superficial veins are frequent and complete. The passage of blood containing the dye from deep to superficial circulation and vice versa in the leg and lower thigh seems very rapid. Retrograde flow of the dye has been seen with both deep and superficial block.

In the normal subject, where a larger vein which is not carrying any dye is joined by a smaller vein with a good concentration of dye the latter usually is not too diluted to demonstrate the entire lumen of the larger vessel. In the pathological case where the smaller vein is normal but the lumen of the larger vein is distorted, this distortion may be demonstrable by the dye.

Combining our knowledge of the anatomy of the venous structures with the knowledge of physiology which has been gained by venographic procedures makes it comparatively easy to interpret the gross pathological case. In the presence of old or recent thrombophlebitis, the first and most important observation is the complete absence of dye in part or all of the deep circulation. In cases of recent thrombophlebitis of the superficial vessels, a definite block and absence of dye in a portion of the superficial circulation can easily be demonstrated. With occlusion of the entire deep circulation, including the deep veins of the leg, the popliteal and femoral, the dye will go upward through the superficial veins. It gradually reaches the internal saphenous and the entire volume continues upward through this channel into the region of the femoral fossa. In most cases, at this point it passes inward and up through the iliac veins. We have seen one such case in which the block was of forty years' standing and numerous varicosities were present over the upper, inner portion of the thigh and lower abdomen. The dye passed up through the internal saphenous to about the mid-thigh, or slightly above. About half of it then passed out through a large superficial vessel into the varicosities and through



these spread upward to the abdominal wall.

One of the rather common findings in cases of thrombophlebitis has been the demonstration by retrograde filling of short sections of communicating veins extending away from the main trunk carrying the dye upward. This appearance has been helpful in completing the diagnosis of thrombosis. With a very recent phlebitis or an older phlebitis which is showing recanalization, the lumen of the vein may be grossly distorted. Occasionally, what appears to be the shadow of the thrombus itself is seen. In these cases, the wall of the vein, or the small area around the wall, will be demonstrated by means of a thin film of the dye which appears to pass along the wall and outline the defect in the center. Some cases of long-standing thrombophlebitis in which recanalization has apparently taken place show very irregular outlines of the vein lumen. The pattern of the dye, as it proceeds upward through the vein, is of irregular density.

We have seen one case in which the large veins of the thigh and leg were markedly calcified. This venous calcification differs considerably in appearance from calcification in the arteries. The picture is one of large, irregular plaques of calcium and it is evident that the lumen of the vessel is larger than that of the ordinary calcified artery.

Clinically, in a number of cases which pass the usual test for patency of the deep veins, venography has shown partial or fairly complete occlusion of most of these. This does not seem surprising in view of the very numerous anastomoses between the deep and superficial circulation and the extreme readiness with which the dye appears to pass from one to the other and back again. Certainly, venographic procedures make one wonder how it is possible to inject a sclerosing solution into any portion of the venous structures of the leg and expect that solution to stay where it is needed. In our experience venography has given a great amount of information not obtainable clinically. This information



Fig. 6. Thrombus in an external vein. This is the typical appearance, as described by Bauer, of a thrombus in a vein. The dye is going up largely through the deep circulation, a small amount passing upward through the internal saphenous. This case was proved at operation.

has shown the surgeon what procedure should be followed.

#### SUMMARY

A serial method for the study of the venous structures of the leg has been described, and a number of anatomical and physiological observations have been recorded. From these physiological observations, we believe that pathological deductions can be made in most cases with considerable certainty. We feel definitely that this procedure should invariably precede any efforts to produce sclerosis or any operative interference with the veins of the leg. Finally, we would make a plea that the procedure be put into more general use and that more surgeons become acquainted with its value.

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## DISCUSSION

S. H. Sedwitz, M.D. (Youngstown, Ohio): These studies were originally undertaken after observing the work done in Boston by Homans and Welsh, Fine and Sears, who employed venography for the purpose of detecting early postoperative thrombophlebitis. Even after infarcts were present in the lungs they injected diodrast (20 c.c., 35 per cent) into the distal vein, generally cutting down on the external malleolus to find a quite constant small vein that communicates with the deep circulation. One minute was required for the injection. In this way it was possible to demonstrate the presence of a blocked deep vein low in the ankle, the source of the emboli in the lungs. Fortunately, the necessity for such a demonstration is rare. Even after involvement of the lung has occurred, however, it is worth while to inject the leg. This does not involve any danger and may reveal the source of the infarcts and definitely clear up any question of differential diagnosis between atelectasis and embolus.

This phase of the work, however, is of less interest to me than its application to varicose veins. When a patient is seen with a thrombophlebitis of fifteen or twenty years' duration with evident varicosities and ulcers, the surgeon's impulse is to ligate and inject the involved vessels. Even after testing for the condition of deep circulation by accepted procedures, however, as I stated in a paper published in the *American Heart Journal*, I must admit I have had some bad results. In these unfortunate cases, where chemical sclerosing resulted in a choked leg. I have had to resort to hospitalization and active physical therapy, which involve loss of time and expense to the patient.

Up until a year ago, when we first started venography, I had 10 per cent postoperative complications following massive injection and ligation and section of the long saphenous vein. Since we instituted venography before operating I have had no such postoperative complications in 120 cases.

We employ venography routinely in patients

giving a history of possible thrombophlebitis or chronic infected ulcers where there is a local infective thrombophlebitis in the region of the ulcer. It is dangerous to ligate the vein high up and inject it, blocking it from above, since this may lead to destruction of the collateral circulation. I would prefer to keep the varicosity and try to cure the ulcer by bandaging and other conservative measures rather than inject the vein and have the patient left with the ulcer and an edematous leg.

Another condition of interest is traumatic phlebotrombosis. Patients sustain injuries to the extremities resulting in lesions about the joints. There may be swelling and edema, as well as ecchymosis or establishment of a definite hematoma which can be seen. A venogram shows a blocked vein with a definite phlebotrombosis, which is extensive and progressive. Since it is painful and the patient does not undertake any active physical motion of the extremity, the thrombosis will extend to a valve, generally the saphenous femoral valve, where it is blocked. If in such a case a venogram is made immediately after traumatism, it can readily be seen where the vein has been broken and where the thrombus arises, and with superficial novocaine block the surgeon can tie off the vein and prevent the extension of the thrombosis. Medicolegally this is a very good point, since the adjusters cannot question the fact when a diagnosis of phlebotrombosis is made.

I was asked recently whether the injection of diodrast is contraindicated in the presence of a postoperative thrombophlebitis, whether it will incite loosening of an embolus. When there is a thrombophlebitis, the passage of blood or diodrast is prevented by the clot and it is shunted to other channels. The injection is given with a 26 or 28 gauge needle into a small vessel, very slowly and there is no possibility of dislodging an embolus. We have had occasion to inject diodrast following sympathetic nerve block with novocaine where the vessel is relaxed, but even under these conditions dislodgment has not occurred, so one need have no fear on that score.

I believe we are obtaining more exact information, free from doubtful interpretation, by taking our films in series. Where only one film is taken at the end of the injection (allowing one minute for 20 c.c.), the veins may show deficient filling, due to spasm, and faulty diagnosis may result. With serial films enough time is allowed between films to judge whether the deficiency is due to spasm or actual thrombosis.

# The Roentgen Diagnosis of Biliary Tract Tumors<sup>1</sup>

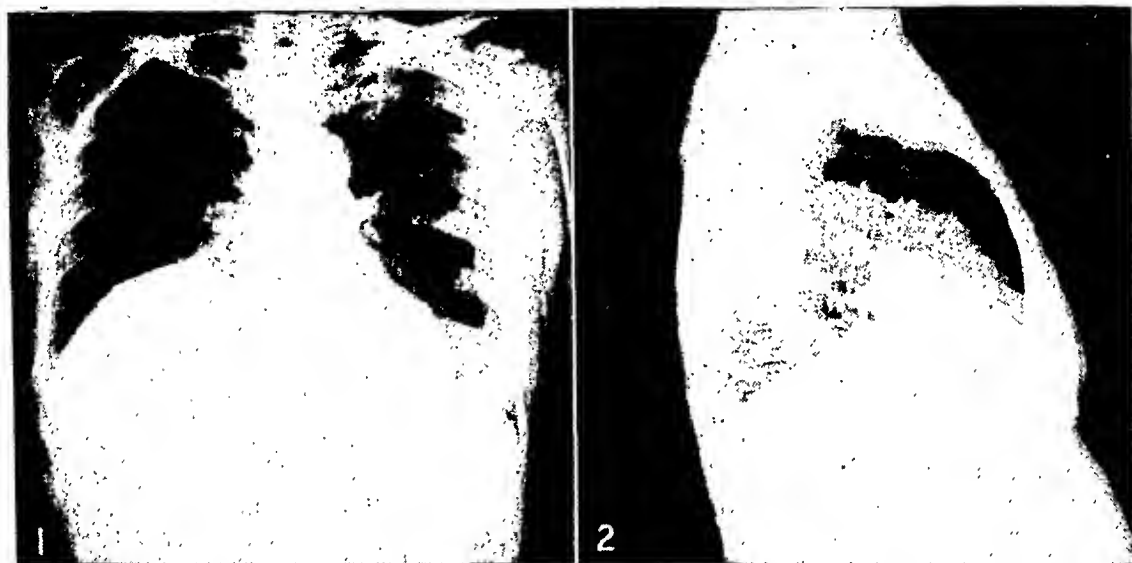
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IN THIS DISCUSSION of the roentgen diagnosis of biliary tract tumors, the word tumor is being used in its larger sense, referring to all those organic lesions which are characterized by enlargement, be it inflammatory, non-inflammatory, or neoplastic.

Roentgen examination has proved to be most successful in the diagnosis of tumors

from normal are discovered, roentgenograms should be made, both anteroposteriorly and laterally. Attention should be paid particularly to the position, shape, and mobility of the diaphragm, which is often affected by abnormal conditions in the organs above or below it. One of the most frequent findings is unilateral elevation of the diaphragm on



Figs. 1 and 2. Elevation of the diaphragm due to enlargement of the liver: anterior and lateral views. In the lateral view the elevation of the diaphragm partially obscures the heart and lower dorsal spine. The relative position of the costophrenic angles is maintained and they are free.

of the liver, gallbladder, and extrabiliary ducts when it is carried out in a methodical order: first, a fluoroscopic inspection of the chest; second, a general survey of the abdomen with plain films; third, a study of the gastro-intestinal tract for any possible alterations in position and contour as a result of extrinsic pressure by enlarged neighboring organs.

The fluoroscopic inspection of the chest seeks to determine the presence of anything abnormal about the heart, vessels, lungs, and diaphragm. If any departures

the right side as a result of an enlarged liver, subphrenic abscess, phrenic paralysis, atelectasis, or eventration. As a rule, the cause of the elevation is readily determined; if not, an examination of the stomach and bowels with a barium meal and enema may help to establish the diagnosis. It has been found that, with enlargement of the liver, the stomach and duodenum are displaced to the left and backward and the colon downward. In all other conditions the stomach and colon are usually pulled upward in the same direction as the liver.

In the presence of a subphrenic abscess the diagnosis is somewhat more difficult,

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

owing to the fact that the diaphragmatic elevation is brought about, not by the liver, but by the fluid between it and the diaphragm. Under this condition the liver may remain in normal position or may even be displaced downward, giving the impression of enlargement. Certain other changes, however, are frequently associated with subphrenic abscess, as, for instance, flattening of the elevated diaphragm with obliteration of the costophrenic angles. This picture differs from that in elevation due to all other conditions, in which the arc-like configuration and the relative position of the costophrenic angles are maintained (Figs. 1 and 2).

The degree of mobility of the diaphragm has not proved to be of great use in the differential diagnosis, being more or less impaired under all circumstances.

The second step in the roentgen examination consists in taking plain anteroposterior views of the abdomen and, at times, lateral views as well. The value of the plain views for a general survey of the abdominal structures is too well known to require any special emphasis; yet, it is often overlooked by radiologists. The information obtained is at times sufficient to establish a correct diagnosis, while at other times it may reveal an important hint about an organ deserving of special attention.

Besides the anteroposterior and lateral views, it has often been found advantageous to make use of the left anterior oblique position in order to separate the shadow of the right kidney from a superimposed shadow of a large gallbladder. In this position the shadow of the gallbladder is displaced to the right of the kidney.

The final step in the roentgen study consists in the examination of the gastrointestinal tract with the aid of a contrast meal and enema, but not for its own sake, since only extra-gastro-intestinal tumors are being considered. The purpose is to determine the existence of any deviation in the position and contour of the hollow viscera as a result of extrinsic pressure on the part of an enlarged adjacent structure.

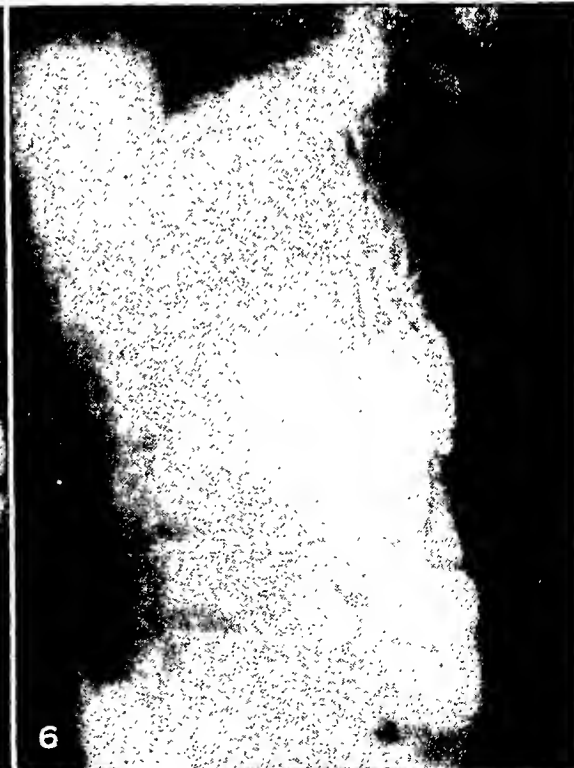
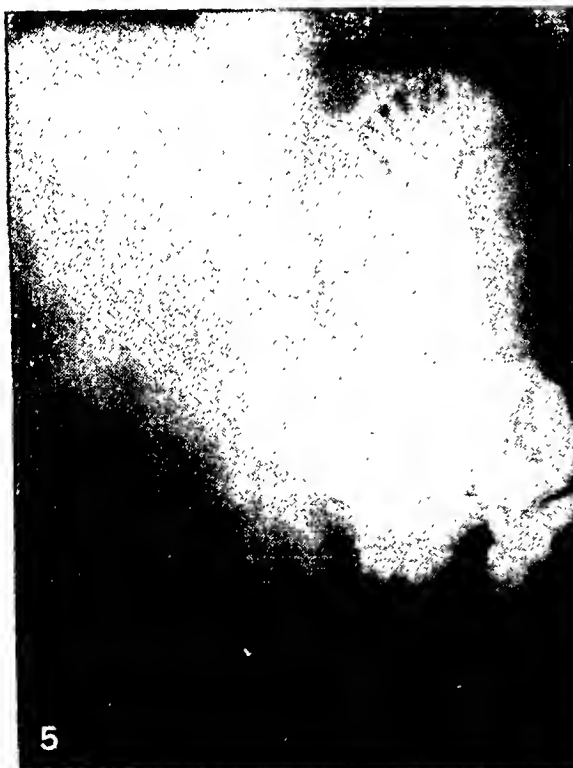
Under normal conditions the organs in the abdomen occupy a definite place and bear a constant relation to each other. In the presence of an enlarged organ or mass, the position and contour of the stomach and bowels, which are, relatively speaking, freely movable and flexible, will assume a certain characteristic pattern and direction according to the position of the body as a whole and the particular organ affected. A knowledge of these facts has often helped in arriving at an accurate conclusion as to the presence, location, and origin of tumors of the biliary tract.

The following changes in the stomach and bowels have been observed in the presence of an enlarged liver. With the patient in the recumbent position, the stomach and duodenum are displaced to the left in the anterior view (Fig. 3) and backward in the right lateral (Fig. 4). In the presence of a tumor arising from the right kidney or the retroperitoneal lymph nodes the stomach and duodenum are similarly displaced to the left, but in the right lateral view the displacement is forward instead of backward. A tumor originating from the gallbladder will also displace the stomach and duodenum to the left (Fig. 5), but in the right lateral view there is no displacement, either forward or backward (Fig. 6), since the gallbladder lies neither behind nor in front of the stomach, but only at its side in the same plane.

In the roentgen diagnosis of tumors of the common duct a knowledge of the exact relationship between the gallbladder, ducts, pancreas, and duodenum is essential. Attention is especially called to the position of the neck of the gallbladder and the cystic and common ducts, surrounding the duodenum at the superior angle on three sides, and forming, together with the head of the pancreas against the inferior surface, a clamp-like tubular structure around the circumference. In view of the above anatomical relationship, it is obvious that anything which increases the caliber of the tubular system around the duodenum may produce some degree of pressure whereby a defect in its contour



Figs. 3 and 4. A case of enlarged liver. In the anterior view (Fig. 3) the stomach and duodenum are displaced to the left and the colon downward. In the right lateral view (Fig. 4) the stomach is seen to be displaced backward as well.



Figs. 5 and 6. A case of enlarged gallbladder. The anterior view (Fig. 5) shows displacement of the stomach to the left. In the right lateral view (Fig. 6) the stomach and duodenum are displaced neither backward nor forward. Note the pressure defect at the superior angle of the duodenum due to a common duct tumor.

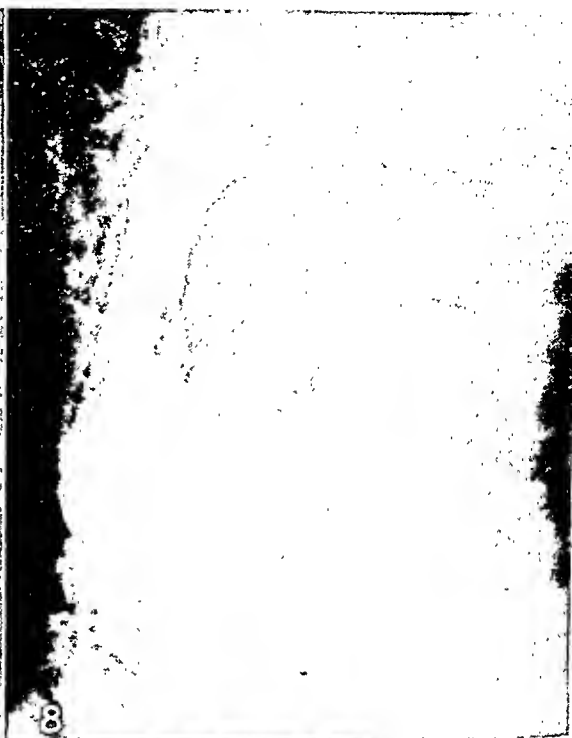


Fig. 7. Right lateral view, showing the normal position, shape, and relation of the duodenal loop surrounding the head of the pancreas.

Fig. 8. Right lateral view showing duodenal loop of normal size, with pressure defect at the superior angle due to dilatation of the common duct as a result of a new growth in a case of obstructive jaundice.

Fig. 9. Right lateral view showing enlargement of bulb, with deformity at the superior angle due to a new growth of the common duct in a case of obstructive jaundice.

Fig. 10. Right lateral view showing duodenal loop of normal size, with pressure defect at the superior angle due to a stone in the neck of gallbladder, in a case without jaundice.

may result. This has been found to be the case in many common duct obstructions.

In an earlier paper, which dealt with the diagnosis of pancreatic tumors, attention was called to a pressure defect in the contour of the duodenum in the region of the superior angle or thereabouts which was observed in the presence of obstructive jaundice. On operation or at autopsy in such cases the common duct was found to be dilated to a greater or less degree in every instance, the cause of the dilatation being either a new growth or stone in the common duct. Since then a considerable number of similar cases have been studied and the previous observations have been fully confirmed.

The most satisfactory view for demonstrating the pressure defect in the duodenum is the right lateral or right anterior oblique, with the patient lying on the horizontal fluoroscope. In this position the entire duodenal loop is seen in its true perspective surrounding the head of the pancreas (Fig. 7). The diameter of the duodenal lumen varies more or less during the passage of the barium meal depending upon its tonicity and the quantity of the opaque medium present. Under normal conditions the contour remains fairly regular throughout the entire course, so long as there is a sufficient amount of the contrast medium. In some cases of biliary tract disease an interruption in the passage of the barium mixture was noted at or just beyond the superior angle of the duodenum. This interruption manifests itself by a defect in the contour of greater or less degree (Fig. 8). In some cases the defect is transient, while in others it may be of a more permanent nature. In the latter event, there are signs of obstruction, as shown by delay in the passage of the opaque medium and often by dilatation of the bulb (Fig. 9). In a number of cases, where such defects were found, operation or postmortem study revealed a dilatation of the common duct, cystic duct, or neck of the gallbladder, explaining the pressure defect upon the duodenum. This roentgen

sign has been found to be present in practically every case of obstructive jaundice due to a stone or a new growth in the common duct. The sign is absent, however, in non-obstructive jaundice, a very important differential point in some obscure cases. It was also found to be present in several patients without jaundice. Upon operation it proved to be due to large stones lodged in the neck of the gallbladder or cystic duct (Fig. 10).

#### CONCLUSION

This paper discusses the roentgen diagnosis of tumors of the liver, gallbladder and extrabiliary ducts. Attention is called to the frequency of elevation of the right side of the diaphragm as a result of an enlarged liver and the method of differentiation from other conditions which affect the diaphragm in like manner.

Attention is also called to the displacement of the stomach and duodenum to the left and backward in the presence of an enlarged liver and to the left only in the case of gallbladder enlargement.

Special emphasis is placed upon the roentgen demonstration of a defect in the lumen of the duodenum, in the region of the superior angle, due to pressure from dilatation of the neck of the gallbladder, the cystic or common duct, as the result of obstruction from a new growth or stone.

Several roentgenograms are presented illustrating tumors of the liver, gallbladder, and extrabiliary tract.

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# Röntgen Rays in the Treatment of Cervical Lymphadenitis<sup>1</sup>

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AS EARLY AS 1898 Pfender mentioned roentgen rays in the treatment of scrofula, and in 1903 Pfahler and others published the first reports of encouraging results following radiotherapy of tuberculosis of the lymph nodes. Since then many clinics have demonstrated the value of roentgen rays in the treatment of cervical lymphadenitis, indicating that roentgen irradiation is one of the most important therapeutic agents in the management of that disease. In 1922 Lahey and Clute reported the end-results of surgical treatment but they emphasized that the best results were obtained in patients who were treated early and in whom complete excision of the nodes was possible; if sinuses or abscesses were present, chances of complete cure were not so good. In 1940, Lahey, Hare, and Haug showed that 80 to 90 per cent of patients responded to x-ray radiation, so that radical operative measures proved unnecessary. They stated that radical operation leaves poor cosmetic results and that there is a higher percentage of recurrence when surgery alone is employed. For these reasons, radical surgery is now rarely resorted to. Well guided surgery, however, in conjunction with irradiation can be considered as the most practical method in the management of this condition.

The follow-up of a group of patients demonstrates the satisfactory results of irradiation. Since tuberculous cervical lymphadenitis is an inflammatory process, frequently of marked chronicity, the rationale of the treatment adopted is based on the known favorable effect of small doses of roentgen rays upon inflammatory conditions. In some cases the tuberculous

process within the node runs a comparatively short course. The elapsed time between the apparent onset of the disease and healing varies from several weeks to several months, or even years.

## TYPE OF MATERIAL

In planning treatment and anticipating results, one must consider the hereditary and economic background of the patient as well as the extent of the lesion. The run-down, undernourished, overworked patient of poor social and economic status who lives in crowded unhygienic quarters will respond more slowly to therapy. Race and nativity are likewise contributory factors. Many of our patients are Negroes and Puerto Ricans, among whom a change of climate and living conditions results in a higher incidence of the disease. This condition resembles the childhood type of tuberculosis and is seen most commonly in Negroes between the ages of sixteen and forty years.

## FINDINGS AND COURSE

Early diagnosis is of the utmost importance. Hyperplastic nodes may be present for years, giving few or no symptoms, and frequently are neglected by the patient. As the disease progresses, however, the breakdown of a node together with local inflammation and pain, and general weakness occasionally accompanied by low-grade fever, night sweats, and loss of weight cause the patient to seek medical advice. The involved lymph nodes are enlarged, discrete, and most often located in the posterior triangle of the neck, either unilaterally or bilaterally. Unless they break down, they are sharply outlined and well circumscribed. There is little or no associated mediastinitis.

The nodes may attain huge proportions before breaking down. On the other hand,

<sup>1</sup> From the Radiation Therapy Service, Dr. Ira I. Kaplan, Director, Bellevue Hospital, New York, N. Y. Presented before the Radiological Society of North America at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.



caseation and necrosis may occur early. In the beginning stages, the physical findings are meager and in many instances remain obscure until a careful complete examination, including biopsy and roentgenograms of the chest, is done. The sputum is usually negative, and biopsy and roentgen studies are therefore of prime importance. In pulmonary tuberculosis of adult type, enlargement of the cervical, supraclavicular, hilar or mediastinal nodes is usually not demonstrable and, while there may be involvement of the mediastinal nodes, the appearance of the parenchymal lesion is far more obvious and is frequently the only diagnostic consideration. In mediastinal tuberculosis, on the other hand, the formation of large masses of nodes is readily demonstrable on roentgen examination of the chest. In children there is practically always associated lymph node involvement.

In patients with involvement of the supraclavicular nodes, the process may extend to the mediastinum or along the trachea, occasionally producing actual displacement. Small calcified nodes, observed in chest roentgenograms, indicate old tuberculous lesions which have healed. In some instances, these are the only evidence of tuberculous infection, while other patients show additional scars of old primary foci in the apices or scattered throughout the parenchyma of the lungs. In hyperplastic lymph node tuberculosis there is generally no evidence of parenchymal involvement of the lung until the later stages. When, however, the nodes are of the fibrocaseous variety, there may be early minimal or extensive pulmonary infiltration.

The size and contour of the nodes in many borderline cases do not determine the diagnosis, since the presence of disease can be established only by the clinical and physical findings, with biopsy or culture. The subsequent clinical course and comparative roentgen studies made at frequent intervals prove that the adenopathy is characterized by a hyperplastic reaction of the lymph nodes to the infecting organism. The therapeutic roentgen test has

proved helpful; if the enlarged nodes are of inflammatory origin they will respond by regression. The general management of this type of case involves hygienic measures, as rest, adequate diet, and favorable surroundings, such as are indicated in the treatment of other forms of tuberculosis.

Four hundred and nineteen patients with lymphadenopathy were treated in the Radiation Therapy Department of Bellevue Hospital during 1924 to 1941, inclusive. Routine chest examinations were done in all cases, and the impression was gained that tuberculous cervical adenitis is not often associated with active tuberculous involvement of the lungs. When tuberculous nodes are situated in the supraclavicular area or in the axilla, however, there is usually an associated active pulmonary tuberculosis. Of the 419 patients, 305 had positive biopsies and in 12 positive tuberculous cultures were obtained from aspiration of the fluctuant nodes. The remaining 102 patients were accepted for therapy because of the clinical findings, despite the fact that in most of these biopsies did not show tuberculosis.

#### TREATMENT

No standard method of treatment for all patients is possible. The factors used vary with age, race, and extent of the disease. In children and younger patients with superficial lesions, low-voltage or medium-voltage x-ray therapy was given. The factors used were 100 to 120 kv., 5 ma., 2-4 mm. Al, 30 to 40 cm. T.S.D., portal sufficient to cover the area involved; 100 r were given at a treatment once or twice a week, up to a total of 600 to 800 r, measured in air. In colored patients pigmentation of the skin is frequently seen after one or two treatments; continuation of therapy in these cases is guided by the clinical response. Incision and drainage are frequently necessary when the mass becomes fluctuant.

In patients with deep, large nodes, particularly where several nodes had become confluent, deep x-ray therapy was



employed, the factors in these instances being 200 kv., 5 ma., 0.5 mm. Cu, + 1 mm. Al filter; 0.9 H.V.L., 40-50 cm. T.S.D.; 100-150 r were given at a time, one area being treated twice a week. The size of the irradiated field varied with the extent of the lesion. The total dose given was 700 to 900 r in air. This was repeated if necessary in six to eight weeks.

#### ANALYSIS OF RESULTS

Regression and healing of the nodes and sinuses were usually so complete that hardly a trace of the original lesion could be detected. In 310 of the 419 cases follow-up observations are available. Of these, 140 received one course of therapy, while two, and even three courses were necessary in others. Pain and tenderness were relieved after the first course of therapy. In many cases, however, with draining sinuses, healing occurred only after the second or third course of therapy. We found no characteristic histologic structures which would serve as an indication of a favorable response or resistance to radiation therapy.

All types of cervical adenitis were treated, including (1) small isolated nodules, (2) multiple nodes of various sizes, (3) large masses of confluent nodes, (4) fluctuant masses, many with draining sinuses.

X-ray examination of the chest was done routinely in all cases. Active tuberculosis was found in 19 patients, suspicious activity in 30, interstitial changes in 102, calcified foci in 109. One hundred and sixty patients showed no chest lesions.

In 9 patients active pulmonary tuberculosis developed following therapy, an occurrence which can possibly be explained on the basis of known pathologic changes and the probable pathogenesis of the disease. It is probable that the cavities first observed on routine periodic examination of the chest were uncomplicated tuberculous lesions, and that the progress of the latent tuberculosis was aggravated by roentgen therapy. It is generally known that the activity of exudative tuberculous

lesions is increased and that caseation is accelerated by irradiation. In these patients, therefore, a quiescent tuberculous focus may have been activated or the pulmonary parenchyma may have been rendered more vulnerable to tuberculous infection.

The age incidence in this series varied from three weeks to seventy years, the largest age-group being that from twenty to thirty years. There were about the same number of male and female patients, showing that there was no sex predilection. Both sides of the neck were equally affected. Bilateral involvement was seen in some patients, while some had axillary, inguinal, and/or mediastinal node involvement. In 310 patients followed there was complete disappearance of the lesions in 178, partial disappearance in 101, and slight improvement in 31.

The follow-up in a large municipal institution, such as Bellevue Hospital, is not entirely satisfactory, since many patients do not return. Many feel that if the condition is improved there is no necessity for further visits; the economic status of many patients does not permit frequent revisits, while a considerable number move frequently, without leaving a forwarding address and cannot be reached by letter or by the social worker.

#### SUMMARY

1. A study of 419 patients indicated that roentgen therapy combined with well guided surgery is the most practical method of treating tuberculous lymphadenitis.
2. The radiation technic varied with the case. Both low-voltage and high-voltage x-rays were used.
3. It was found that active pulmonary tuberculosis was present or developed subsequently only if the supraclavicular, axillary, or mediastinal nodes were involved.

## ROENTGEN TREATMENT OF CERVICAL LYMPHADENITIS

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# A Review of the Scott Wide Field X-Ray Treatment<sup>1</sup>

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WIDE FIELD x-ray treatment as developed by the late Dr. S. Gilbert Scott<sup>2</sup> of London consists of treatment with small doses of low-voltage x-rays, applied to the body from the head to the upper part of the lower extremities, both anteriorly and posteriorly. It is given for its tonic or stimulating effect on the body as a whole, and not for the destruction of any disease. It is intended to build up the resistance of the body to disease. The individual and the total doses are small. The amount of dosage and the interval between treatments must be judged by the tonic effect upon the body as a whole.

The method was first described by Scott in the *British Medical Journal*, May 1921. It was further developed under the Nuffield Research Fund and published in October 1939 in book form, in connection with the Nuffield Wide Field X-ray Therapy Research Fund.

In 1938, Scott was invited to give the Mackenzie-Davidson Lecture before the British Institute of Radiology (corresponding to the Caldwell Lecture before the American Roentgen Ray Society, the Carman Lecture before the Radiological Society of North America, and the Jane-way Lecture before the American Radium Society). He chose this for his subject. He says: "The method must be used for its general stimulating effect," and quotes Pasteur's last words to Renan: "Claude Bernard was right, the microbe is nothing, it is the soil which is all important," and Hippocrates: "The only scientific way of treating disease is by treating the whole body."

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

<sup>2</sup> S. Gilbert Scott, M.R.C.S., L.R.C.P., F.F.R., D.M.R. & E. (Camb.), Consulting Radiologist to the London Hospital; Honorary Radiologist to the British Red Cross Rheumatism Clinic, Lond.; Honorary Physician Radiologist to the Charterhouse Rheumatism Clinic.

The center for Scott's study of this method of x-ray therapy was the Charterhouse Rheumatism Clinic, 56 Weymouth Street, London, W1, and he invited anyone interested in the work to see how the method is applied. I knew Scott for seventeen years and was a guest at his home, but I never found the opportunity of visiting the Clinic, because I had not heard of this method until he sent me his book in 1940. Even then the theory seemed fantastic to me, and I did not start to use the method until six months ago. I have no personal conclusions to report other than that I have found no harmful effects from this method.

I have been doing x-ray therapy during more than forty-two years, and I am convinced that we have much to learn. The skillful application of x-ray therapy involves a great deal more than a knowledge of physics, which is admittedly very important. The biological effects upon the body as a whole, and upon the tissues surrounding the diseased area, the blood, the endocrine glands, and their secretions, etc., as well as the quality of rays, the size and proper distribution of the tissue dosage, and the interval between doses, need much study. Scott's method was applied by him beginning in 1918—twenty-four years ago—yet it will seem revolutionary to most of us.

Scott began his research upon this subject in 1920-1921, at the London Hospital. The first 50 cases submitted to wide field x-ray treatment were under constant observation during one year, with the main object of determining whether any harm was being done. Instead of harm, an all-round improvement was observed in every case. There was nothing to suggest anemia or leukopenia in any instance. Several of the patients were shown about this time at the Royal Society of Medicine, and the method was described in the *British Medi-*

*cal Journal* for May 1921. The method became established at the London Hospital as a routine prophylactic measure in all cases of malignant neoplasms, being *used as an adjunct* to the heavier local application of the x-rays to the primary growth. While Scott was not able to collect enough reliable data to justify a statistical report of his results, he nevertheless wrote: "I am personally so convinced of its therapeutical value, that I have never ceased using it in all cases of malignant disease as a method of treatment to be employed where necessary in conjunction with the heavy local radiation to the primary growth."

We all know how difficult it is to draw scientific conclusions from purely clinical observations, and we must realize, therefore, that Scott was giving us his personal impression rather than scientific proof.

During 1933 the "differential sedimentation test" (D.S.T.) was introduced. This was based upon the work of Bendien, and an improved technic was developed by Coke and others.<sup>3</sup> The ordinary sedimentation test was found to be of some value, but the D.S.T. was found to be much superior and proved to be an excellent gauge of the constitutional change, corresponding to the clinical results. This test was used by Scott as a guide in determining his results. This test showed that the greatest deviation from the normal seemed to occur in the *serum* of the active or chronic infective or chronic allergic case, and it is in those cases in which the sedimentation rate is raised and a definite abnormal condition of the blood serum is present that the best results are obtained by the wide field method of x-ray treatment. While this test is not essential or used in the routine case, it has been found of great value in determining the correct saturation point and in avoiding oversaturation. A considerable number of cases of spondylitis have now been treated by this method and the D.S.T. has been used in conjunction with the treatment.

Scott says: "I suggest that x-rays should be considered as the most powerful and possibly the most valuable therapeutical agent in medicine."

#### TECHNIC

Scott's investigations have shown that the essentials of success with wide field x-ray therapy are as follows: (1) a heterogeneous primary beam, using x-rays of the long medium wave length with appropriate filters; (2) a large field, which must include the whole trunk; (3) optimum distance of the tube to the patient (20 inches); (4) correct choice of case; (5) correct adjustment of dose for the particular patient; (6) familiarity with the signs of saturation.

*Wave Length:* Grotthus' Law (1818) reads: "Only those rays which are absorbed can produce chemical changes." The technic recommended by Scott is: 130 kv., 3 mm. Al, 60-100 r, half the dose being given anteriorly and half posteriorly, at 50 cm. distance.

*Field:* Investigations have shown that to obtain the desired constitutional effect, the abdominal area—that is, the area below the level of the diaphragm—must be included in the radiation field. In asthma a certain modification has been introduced for various reasons, so that only the abdominal area is submitted to irradiation, the thoracic section being entirely excluded. With this single exception, the whole trunk is always included in the radiation field. It is technically difficult to obtain a large enough field at the optimum distance of 20 inches. The inclusion of the thyroid gland found at one extremity of the field and the genital organs at the other is advisable even though the dose actually received by these organs is small due to their situation at the periphery of the radiation circle.

*Reaction:* Usually vague abdominal discomfort, sometimes described as biliousness, or slight nausea occurs within twelve hours after treatment. Under no circumstances should the patient experience more than this, for the sedimentation rate

<sup>3</sup> The Charterhouse Rheumatism Clinic Original Papers.

and differential sedimentation test have shown that there is otherwise a risk of creating a so-called "negative phase," a condition that, if continued, may be detrimental to the patient.

### CONCLUSIONS

In presenting this review of Scott's method of "wide field x-ray treatment," I am giving to you nothing that is original with me, but when a friend and British colleague presents to us his observations covering a period of more than twenty years, they deserve serious consideration. His distinguished hospital connections, the fact that his investigations were made under a Fund established for this purpose by Lord Nuffield, and the invitation of the British Institute of Radiology to give the Mackenzie-Davidson Lecture at its Annual Congress in 1937, give Scott's observations more than ordinary prestige.

I have been using this method in conjunction with my regular local treatment in a considerable number of cases during more than six months and have seen no harm. I believe I have seen some benefit.

1930 Chestnut St.,  
Philadelphia, Penna.

### DISCUSSION

Helen B. Flynn, M.D. (Chicago, Ill.): I have studied cancer from the standpoint of the infectious theory and I can see some wonderful things in the wide spread x-ray technic, but a word of caution should be given. Watch your patients when you use it. Each one will respond differently.

What x-ray treatment does, whether it is high-voltage or low-voltage, whether it is concentrated or disseminated, is to kill off the cause of the disease and, as every bacteriologist knows, regardless of what the organism is a certain amount of toxemia results. To take, as an example, the treatment of granulomata; in the patient with a severe infection the liberation of large amounts of toxin will produce a result quite different from that in the patient with a low-grade toxemia, and this holds good not only in cancer but in all the granulomata—syphilis, tuberculosis, etc. *When you are x-raying a patient, watch for the degree of toxemia following treatment.*

Ira I. Kaplan, M.D. (New York): I would like to recall to Doctor Pfahler what we saw in England back in 1922 in Knox's laboratory. He had a big wagon wheel fixed to the ceiling and attached by a

belt to a gas engine. On the wheel was an x-ray tube. The patients were stretched out on the floor in a sort of sundial effect, the gas engine was started, and as the wheel turned, the radiation was distributed to the patients for what it was worth.

Another method was that of Dessauer in Germany, probably in 1921 or 1922. The patient was placed in a box in which there was a rotating x-ray tube so that he received a box-like effect of radiation all over the body. Scott's method seems to be somewhat similar in purpose.

Joseph Ernest Gendreau, M.D. (Montreal, Quebec): Wide field irradiation has been used for many years, and at different meetings in Europe papers have been presented describing it. We have long used the method in Montreal. In fact, one of our fifteen tubes is devoted exclusively to that form of therapy. We use 200 kv. and a distance of 1 or 2 meters. The method is, however, dangerous. I know that in Europe cancer patients have died following its use.

This method of treatment must be carefully studied. Astonishing effects are shown with very small dosage. Even with 25 r we have had some surprising results. Effects on the blood are, of course, sometimes distressing. Such therapy has been used for generalized cancer, Hodgkin's disease, and similar conditions with satisfactory reactions. Improvement has also been obtained in benign conditions, but the danger is so great that prudence must be the rule.

Perhaps we do not use the same way of measuring, but 150 r is a huge dose; 25 r is a moderate dose, and 50 r repeated may cause serious discomfort and danger.

There remain certain questions for study. How, with such small dosage, can we obtain favorable results that are certain? How is the general reaction of the body to be explained? Some adequate explanation, aside from the volume involved, must be found. Meantime, in proceeding with the method we must be very prudent, awaiting more scientific study and adequate statistics.

Merle Franklin Godfrey, M.D. (Glendale, Calif.): It was my privilege to be associated with Dr. Gilbert Scott for a number of months in London, both at the Charterhouse Rheumatism Clinic and at the British Red Cross Rheumatism Clinic, in the year 1935. I did not know that he had done anything in the treatment of cancer with this form of irradiation.

I did have the opportunity, however, of watching the effects he obtained in cases of spondylitis adolescents, particularly as associated with pathology of the sacro-iliac joints, as well as to observe his work in patients with asthma. Results in cases of both types were gratifying, as conceded not only by Doctor Scott but by all the men connected with both clinics.

Actually, about 35 per cent of asthmatic cases

seemed to be considerably improved by this wide field therapy. I won't say that they were "cured," but the patients appeared better and stated that they felt better. This physical improvement was usually paced by improvement in the findings by the differential sedimentation test, as devised by Coke, Crowe, and Scott.

I saw no ill effects following Doctor Scott's technique. There may have been some, however. These patients seemed to get a physical lift and I believe that those who react badly, as mentioned by one of the discussants, are probably those in whom curious metabolic changes take place, releasing toxic substances which act as a systemic poison.

George E. Pfahler, M.D. (*closing*): I think we must first of all understand clearly that the treatment I am describing (not my own) is not the teleroentgen therapy which has been used for the most part to destroy disease. I stated that quite definitely in my introductory remarks.

This treatment is given for its stimulating effect on the resistance of the body; in other words, for its stimulating effect on the normal tissues and not for its destructive effect on any disease. The destructive effect on the disease must come from the

stimulating effect on the normal tissues. That is why I did not bring into the discussion the work that has been done, not only in Europe but in America, on whole body treatment with high-voltage rays such as is recommended by some for leukemia. Dr. Lloyd Brown did a considerable amount of work on treatment of the whole body. That is a different problem entirely.

There is another point I should like to bring to your attention. When the whole body is treated with any dose (Doctor Quimby can tell you this much better than I), one gets a constitutional effect in great part according to the volume of tissue that is treated. Let us say, for example, that we give 100 r to a field  $10 \times 10$  cm. When the same dose is given to the whole body, that field is multiplied many, many times and the constitutional effect will be correspondingly greater. We must always keep that in mind.

With regard to the use of the high-voltage treatment, we are all convinced, I think, that the damaging effect on the blood stream is particularly by those rays that pass through the bony tissue. The low-voltage rays and small doses produce no damage to the blood-making organs, as observed by Doctor Scott.



# An Apparently Solitary Myeloma of Bone with Subsequent Generalization<sup>1</sup>

Favorable Response to Irradiation with Unusual Reactions

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ACCORDING TO THE latest reports (Paul and Pohle; Bichel and Kirketerp; King; Tilden; Esposito), 48 cases of so-called solitary myeloma have been recorded in the literature. Only about one-fourth of these, however, are known to have remained solitary after four years' observation. In approximately 30 per cent the typical picture of multiple myeloma developed after varying intervals and 40 to 50 per cent were observed too short a time to permit a definite conclusion. Bichel and Kirketerp, emphasizing the importance of sternal puncture as a diagnostic aid, accepted as unquestionable solitary myeloma only 5 of a series of 27 cases which they reviewed, mainly on the basis of their long clinical course. They believe that a roentgenographic investigation of the entire skeleton does not wholly exclude the possibility of a generalized myelomatosis in the presence of a single roentgenologically demonstrable lesion, inasmuch as sternal puncture in their two cases showed evidence of systemic disease when roentgenologically no other lesion could be found.

It is a matter of speculation whether these tumors, *i.e.*, the ones which remained solitary after four years' observation, and those which ultimately became typical multiple myelomas, are really representative of two different entities. The important point is that all of these lesions apparently have a better prognosis and respond more favorably to treatment than the classical multiple myeloma. Paul and Pohle incline to the belief that myeloma may occur in varying degrees of malignancy, with rapid progress in the classical cases and a relatively benign course in the



Fig. 1. Roentgenogram of the right hip, Oct. 20, 1939. There is a practically complete destruction of the entire superior ramus of the right pubic bone, with some faintly seen flake-like remnants of bone, suggestive of expansion. The destruction involves the acetabulum as well as part of the innominate bone. This latter involvement is purely osteolytic, with coarse trabeculation and lack of periosteal reaction or bone production. Probably some soft-tissue infiltration is present.

so-called "solitary" lesions. Between the two extremes—*i.e.*, the typical multiple myeloma and the probably permanently solitary tumors—many grades of malignancy may be found. This assumption naturally would favor the outlook in cases with early institution of proper treatment.

From the *roentgen diagnostic* point of view, two main types of lesion have been described. The first is the purely osteolytic lesion with sharp demarcation and little, if any, expansion. This type is most frequently located in a single vertebra or the shaft of a long bone and is easily mistaken for an osteolytic cancer metastasis.

<sup>1</sup> Presented before the Buffalo Radiological Society, Jan. 11, 1943. Accepted for publication in April 1943.

The second, or so-called giant-cell, type is a multicystic, osteolytic, destructive lesion, with rather sharp demarcation and occasional expansion. According to various reports (Paul and Pohle; Pasternack and Waugh), the giant-cell type seems to show less tendency toward generalization and perhaps a better response to treatment, especially to irradiation.

hip and thigh and inability to walk. She attributed her trouble to a fall about seven years previously, in which she landed on her right hip. About five years before admission she began to have pain in the hip and difficulty in walking. These symptoms gradually increased in severity. Finally in 1939, that is about three years after the onset of the pain, she consulted her physician. At that time, save for the right hip region, nothing essential was found on physical examination. The right lower extremity showed a slight generalized atrophy together with



Fig. 2. Roentgenogram of the pelvis, Oct. 22, 1941, showing destructive changes in all the right pelvic bones. Note the two small punched out areas of destruction in the upper remaining rim of the innominate (arrows). Definite soft-tissue involvement is present. Beginning destruction of the left pubic bone at the symphysis is also present.

The case to be presented here was probably of the giant-cell type and apparently originated in the superior ramus of the right pubic bone, with subsequent involvement of the right ischial, innominate, and left pubic bones. Contrary to the statement of Stewart and Farrow, that *bulky* plasma-cell myeloma is radioresistant, there was a favorable response to irradiation in our case. The post-irradiation changes constitute the main subject of this report.

#### CASE REPORT

G. S., a 53-year-old white female, was admitted to St. Francis Hospital, Olean, N. Y., on Oct. 31, 1941. Her chief complaints were pain in the right

some tenderness in the right hip region. The attending physician advised hospitalization and x-ray investigation.

On Oct. 20, 1939, the patient was admitted to a hospital and an x-ray examination of the pelvis was done for the first time (Fig. 1). The tentative diagnosis (Doctor Jaffrey) was a primary malignant bone tumor, possibly chondrosarcoma, osteogenic sarcoma, or plasma-cell myeloma. A chest roentgenogram at this time was entirely negative. Re-examination nine months and again eighteen months later showed the lesion to be progressing, but there was still no evidence roentgenologically of pathological changes in the chest.

On Oct. 22, 1941, just two years after the first roentgen study, the patient was admitted to St. Francis Hospital. The right leg was now about 1 1/2 inches shorter than the left. The right thigh measured about 2.0 cm. and the right calf 0.5 cm. less than in the left lower extremity. On rectal



and vaginal examination, a large, smooth, firm tumor could be palpated on the right side. The movement in the right hip joint was not noticeably limited. The patient, however, was unable to walk without crutches.

On the day of admission, roentgenographic examination of the pelvis revealed advanced destruction in all the right pelvic bones (Fig. 2). An entirely osteolytic lesion was present, with coarse trabeculation in the innominate bone and perhaps some expansion in places. The outline of the destruction was quite smooth in places but mostly

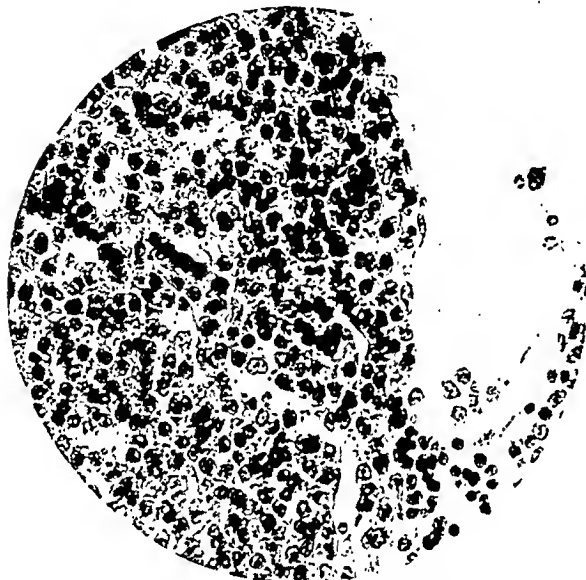


Fig. 3. Section of tissue ( $\times c 300$ ) from tumor of right pelvic bones. Note cellular neoplasm with scanty stroma. The nuclei are occasionally located eccentrically and many reveal a somewhat spoke-like arrangement of the chromatin.

irregular. Soft tissue involvement was present. An especially interesting feature was the presence of at least two small, somewhat punched-out areas of destruction in the upper remaining rim of the right innominate bone, demonstrable on repeated examinations. This finding definitely established the condition as of a multiple—rather than the earlier single—lesion type. A beginning irregular destruction of the left pubic bone at the symphysis was also demonstrable, with suggested involvement of the symphyseal fibrocartilage. These latter findings, the age of the patient (fifty-three), and the location of the tumor were somewhat at variance with the typical picture of the ordinary giant-cell tumor (which was considered as a first possibility). A biopsy was done by one of the writers (J. A. W.) on Oct. 28, 1941. The operative note emphasized the presence of a highly vascular and cellular tumor infiltrating surrounding muscles.

The reports of several pathologists were somewhat contradictory and confusing. Ewing's tumor

and myeloma were considered (Fig. 3). The preferred diagnosis was myeloma. X-ray studies of the thoracic cage, lumbar spine, pelvis, and upper third of the lower extremities were negative at this time, apart from the right pelvic and left pubic bones.

On Oct. 31, 1941, the first series of x-ray treatments was begun. After 150 r/skin dose, a severe reaction occurred, with chills and fever of  $103^{\circ}$  F. We continued the treatment, nevertheless, every other day, though, because of the unpleasant reactions, mostly 80–100 r/skin were given. The rise in temperature following irradiation usually reached its peak three to four hours after treatment. No evidence of infection of the biopsy wound or other explanation for the increased temperature could be found. Furthermore, it was limited to two to five hours following irradiation. No anorexia, nausea, headache, or skin eruption was noted.

We succeeded in giving 15 treatments, totaling 1,700 r/skin through three portals. The physical factors were: 220 kv.;  $20 \times 20$  cm. field; 50–70 cm. target-skin distance; Thoraeus filter; H.V.L. 2.0 mm. Cu; rate about 10–15 r/min. The depth dose at 50 cm. T.S.D., at 11 cm. depth, was about 42 per cent. Some improvement was noticed at the end of the series. The patient gained weight, her appetite improved, and the pain in the right hip practically disappeared.

On Dec. 8, 1941, a blood count showed 2,830,000 red cells with 58 per cent hemoglobin, 9,200 white cells with 71 per cent polymorphonuclears, 3 per cent eosinophils, and 26 per cent lymphocytes.

On Dec. 29, 1941, ten days after the completion of the first series, an x-ray examination of the pelvis showed no evidence of change.

Another series of x-ray treatments was begun on Feb. 9, 1942. Since the same reaction was encountered as in the first series, only 100–150 r/skin were given every other day. The patient received 13 treatments, totaling 1,700 r/skin with noticeable improvement.

Roentgenographic re-examination of the pelvis on April 11, 1942, revealed a considerable trabecular recalcification at the site of the previous destruction. The entire lesion, including the soft tissue swelling, appeared to be reduced in size.

The patient was now discharged from the hospital. She gained about 15 lb., still used crutches, but was fairly active. One day, for example, she rode with her son to a neighboring city about 80 miles distant. She refused further treatment because of the "feverish reactions." The blood count at this time was 3,530,000 red cells with 75 per cent hemoglobin, 4,800 white cells, with 80 per cent polymorphonuclears, 7 per cent eosinophils, and 13 per cent lymphocytes. The sedimentation rate was 45 mm. per hour (Wintrobe) and tests for Bence-Jones protein were negative.

On June 9, 1942, the patient was readmitted to the hospital with severe pain in the chest. X-ray examination of the pelvis at this time showed further

improvement (Fig. 4). Roentgenograms of the chest revealed numerous osteolytic lesions in the ribs, with two healing pathological fractures.

After this last admission, the patient's condition became worse rather rapidly. She complained mainly of pain in the chest and back, accompanied by dyspnea. There was no headache.

On June 10, 1942, the urine showed a moderate trace of albumin, many blood cells, and 20-40 pus cells per high power field. The red cell count was 3,370,000, with 74 per cent hemoglobin; the white cell count was 10,200, with 87 per cent polymor-

phs were fibrotic in most areas, with occasional remnants of tumor cell collections. These tumor remnants, as well as the tumor-infiltrated areas in the ribs, showed a very cellular neoplasm with a scanty fibrous stroma. The tumor cells were fairly large, polygonal or round, with the nuclei occasionally located eccentrically. The nuclei contained from one to three nucleoli and occasionally showed a somewhat spoke-like arrangement of the chromatin. The cytoplasm was ample but did not appear to be granular. The pathological diagnosis (Dr. Leo Moss) was plasma-cell myeloma (multiple).



Fig. 4. Roentgenogram of the pelvis, June 9, 1942. Note the trabecular recalcification in the place of previous destruction. The entire lesion, including the soft-tissue swelling, is reduced in size.

phonuclears and 1 per cent eosinophils. Blood studies on Oct. 17, 1942, showed serum total protein 10.1 per cent, with 5.3 per cent albumin and 4.8 per cent globulin. A formol-gel test was strongly positive. On Oct. 24, 1942, urinalysis revealed a one-plus Bence-Jones proteinuria.

The patient died on Oct. 28, 1942, three years after the first x-ray study and six years after the first appearance of symptoms in the right hip region.

On postmortem examination of the emaciated body the skeletal system, especially the ribs, the right side of the pelvis, and the skull (x-ray), showed the most extensive lesions. Multiple costal involvement was present, with pathological fractures of the right fourth and eighth and left sixth and seventh ribs.

Histologic examination of the irradiated area (tumor of right pelvic bones) revealed the presence of regular bone as well as osteoid tissue. The marrow

As an interesting feature of the autopsy, small collections of tumor cells were found in the spleen. The patient also had a bilateral patchy bronchopneumonia. The kidneys showed only mild arteriosclerotic changes. An x-ray examination of the skull revealed numerous small osteolytic lesions, fairly characteristic of multiple myeloma (Fig. 5).

#### COMMENT

Upon reviewing this case, as well as the literature on the subject, it becomes evident that there are considerable difficulties in the roentgen diagnosis of these at least temporarily solitary myelomas. They are most commonly confused with *giant-cell tumors*. Pohle believes that the age of the patient, location of the tumor, the evidence of cortical destruction, and the somewhat



Fig. 5. Roentgenogram of the skull (postmortem), Oct. 28, 1942, showing numerous small occasional confluent osteolytic lesions, fairly characteristic of multiple myeloma.

coarser trabeculation may help in the differentiation.

These seemingly solitary myelomas usually occur around the age of fifty, are more often found in males, and are located most frequently in the spine, pelvis, and femur. They often infiltrate adjacent soft tissues, as in the case recorded here. The two tiny round areas of destruction in the pelvis were of great value in the differential diagnosis. As another important feature, the partial destruction of the opposite pubic bone in this case, through the symphysis, also deserves emphasis. In vertebral involvement a similar extension of myeloma—sometimes of Hodgkin's granuloma (Dresser)—occasionally occurs across the intervertebral disk. Malignant disease, however, does not as a rule traverse joint spaces. According to Camp and Dresser, the tumor, giving the appearance of having gone through the joint, actually extends around it by way of contiguous osseous or soft tissue structures demonstrable in postmortem specimens. Apparently this sign may sometimes occur in myelomas of extravertebral location also, as

in this case, and is worthy of consideration in the differential diagnosis.

*Osteogenic sarcoma*, especially the *osteolytic* form and the so-called *chondroblastic* type (Geschickter), sometimes closely resembles the myeloma of this case. There are, however, fairly definite signs of distinction. These bone sarcomas practically always present a definite periosteal reaction, usually occur in patients under twenty, and are rarely found in the pelvic bones; their duration is seldom more than two years. *Localized fibrocystic disease of bone* is in general characterized by an earlier age incidence, comparative lack of symptoms, and a tendency to diaphyseal location in long bones. Certain types of *lymphoblastomas* and *hemangiomas of bone* may sometimes present similar roentgenographic features. Perhaps an especially important neoplasm in the problem of differential diagnosis is *Ewing's tumor*. The two conditions may appear identical, not only roentgenologically but even clinically (Liebman and Goldman, Swenson and Stout).

In conclusion, we agree with Paul and Pohle that, "at the present time, it is not possible to make an unequivocal diagnosis of solitary myeloma from roentgenologic examination alone, although the probability of its existence may be correctly stated." Biopsy and marrow puncture, together with blood studies and repeated urinalyses, should be done in all the suspected cases to establish the correct diagnosis as well as to determine possible generalization.

Regarding the result of *x-ray treatment*, we believe that the lesion in our case was probably quite radiosensitive, in view of the changes in the tumor area within a comparatively short time and the severe post-irradiation reactions. On the other hand, the degree of malignancy was probably low, considering the slow progress of the primary lesion. The great improvement in the patient's general condition, the pronounced change in the blood picture from 2,650,000 red cells with 51 per cent Hb. to 3,530,000 red cells with 75 per cent

Hb., as well as the rapid regeneration of bone in the area of destruction in a period of five months, make us wonder about the possible beneficial action of irradiation had it been instituted at the first discovery of the disease, in October 1939.

Finally, a few comments concerning the reaction, with chills and high temperature, after comparatively small doses of x-ray may be added. So far as we are aware no similar reactions have been mentioned in connection with irradiated solitary myeloma. Such systemic changes have been reported, however, in cases of leukemia, cellular carcinoma, mycosis fungoides, etc., by Engel, Holzknecht, Kienböck, MacKee, and others. In most instances the high temperature, with or without skin eruption, followed intensive irradiation and was believed to be a sign of toxemia as "a result of destruction of cellular elements, with the absorption of foreign proteins or biochemical products to which the organism reacts" (MacKee). Holzknecht speaks of four cases with intermittent fever and with a definite dermatitis where he noticed relatively insignificant subjective signs. He believed that this symptom-complex was of toxic nature and that it had a good prognosis.

In the absence of other noticeable subjective changes, and considering the comparatively good result of the irradiation in our case, it is felt that in spite of these systemic reactions similar cases should be treated by roentgen radiation with small fractionated doses.

The study of Bence-Jones proteinuria after these effective x-ray reactions might have been an interesting one.

#### SUMMARY

A case is presented of an apparently solitary myeloma originating in the right

pubic bone with subsequent generalization. The difficulties of roentgen differential diagnosis and the favorable influence of roentgen irradiation are discussed.

Attention is called to the severe reaction—chills and high temperature—following comparatively small doses of x-ray treatment.

NOTE: We wish to express our thanks to Dr. G. Jaffrey for kind permission to use his roentgenogram, as well as to Dr. S. N. Tager and Dr. E. K. Richard for their co-operation in preparing this paper.

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# Recovery of Radium Tubes from Sewer<sup>1</sup>

MARVIN M. D. WILLIAMS, Ph.D.

Division of Physics and Biophysical Research  
Mayo Foundation, Rochester, Minnesota

A SEARCH FOR THREE tubes of radium which had been lost in a sewer, and the recovery of the last of these tubes fifty-four days after it disappeared, involved the use and consideration for use of some equipment which it is believed had not previously been employed for such work. The successful conclusion of this search was due to the suggestions and co-operation received from the hospital authorities, employees of the city engineer's department, members of the biophysics laboratory section, representatives of the insurance company, Prof. J. W. Buchta of the University of Minnesota, and numerous others whom we may have inconvenienced.

The tubes each contained approximately 50 mg. of radium, sealed inside a glass tube, which in turn was sealed inside a tube of Monel metal whose outside dimensions were 27 mm. (1 1/16 inches) in length and 5.6 mm. (a little less than 1/4 inch) in diameter, with a wall thickness of 1.5 mm. At the time the tubes were lost, each was tied in a separate finger cot and had small pieces of gauze bandage adhering to it because of clotted blood. When they were recovered, the finger cots were still attached to the tubes: one cot was still intact, one was slit part way down the side, and one was attached to the tube only by the string; all the gauze had been washed away.

The tubes were removed from a patient about 8:30 P.M. on Sept. 3 and presumably left in a tray, which also contained some instruments and dressings. That the radium was lost was discovered about 9:30 P.M. In the intervening hour the tray had been taken from the patient's room to a utility room, the instruments had been cleaned, and the hopper had been flushed.

A few minutes after 10 P.M. a search was

started with a portable Geiger-Müller counter. As no indication of the radium was found on the floor of the hospital on which the loss had occurred, a rough check of the sewer line was immediately made from the utility room to its point of emergence from the hospital. Tests with a similar tube of radium made at a later date showed that the counter would have indicated the presence of any one of the three tubes if it had been in the hospital sewer line at that time. The wastepaper rooms, the linen rooms, and the incinerator were then checked. All wastepaper and linens were ordered held on the hospital floor until checked with the counter. By that time the hospital superintendent and engineer had arrived, and the sewer line in the hospital was again checked more carefully. The incinerator and the wastepaper and linen rooms were rechecked, and the search was carried through the rest of the hospital. The next morning the hospital, incinerator, linen and wastepaper rooms, and garbage were carefully checked, as were the manholes in the sewer line for a mile from the hospital, the sewage disposal plant, the laundry to which the hospital linens are sent, the laundry truck, the sewer line in the hospital, and roofs below the hospital windows. During the next few days the sewage disposal plant, the city dump grounds, the manholes in the first few blocks of the sewer line leading from the hospital, all wastepaper, and the incinerator were checked several times.

The sewer line for the first mile from the hospital is a tile pipe 12 inches (30.5 cm.) in diameter and 10 to 12 feet (3 to 3.6 meters) below the street surface. The line has a drop of 3 1/4 inches in 100 feet (27 cm. in 100 meters; 0.27 per cent grade) and at times runs two-thirds full of water. About 1 mile (1.6 kilometers) from the

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hospital this line connects with a larger line, and about 1 mile (1.6 kilometers) farther on this joins all the lines from the city and the sewage is carried under a river by means of two siphons. The bottom of the siphons is about 16 feet (5 meters) lower than the sewer line on either side of the river. The disposal plant is about 1/2 mile (0.8 kilometer) from the river.

Ten feet (3 meters) of earth is sufficient to make it impracticable to attempt to locate from the street radium which might be in the sewer pipe. Five or six feet (1.5 or 1.8 meters) of water would also make the use of the Geiger-Müller counter impractical, and there were places in the disposal plant and in some of the manholes near the plant where the depth of water was greater than this.

On Sept. 10, Prof. J. W. Buchta, of the Physics Department of the University of Minnesota, brought additional Geiger-Müller counters and helped with the search. The portable counter tube was covered with a rubber stocking so that it could be lowered about 3 feet (1 meter) into water. The disposal plant, city dump, sewer manholes, the entire hospital, incinerators, linen and wastepaper rooms, and the laundry were again carefully checked, and because of the bare possibility that the tubes might have dropped into someone's pocket or become attached in some manner to someone's clothing, the homes of the physician and nurses and of the patient's wife were checked. A few days later the city hog farm, to which garbage from the hospital is hauled, was gone over carefully.

It seemed most probable that the tubes had got into the sewer and that they might be carried along as far as the siphon under the river, but it did not seem probable that they would be carried up the incline of the siphon to the other side. Mr. Arleigh C. Smith, the city engineer, said that it would be possible to block off one siphon at a time, pump the water out, and then have a man carry a counter through the siphon. Before arrangements for doing this were completed, Mr. Smith came to the

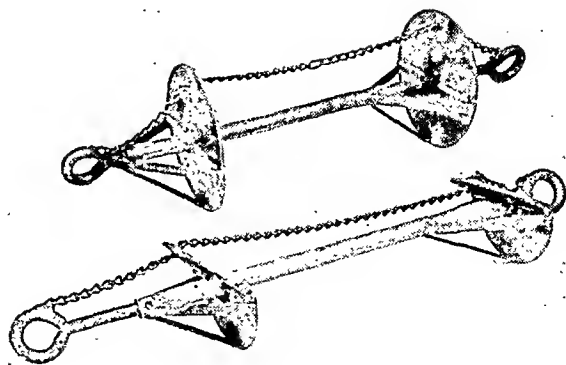


Fig. 1. Sewer scrapers designed by Mr. Arleigh C. Smith with 11-inch (28 cm.) (upper) and 9-inch (23 cm.) (lower) disks. The rod with rings on each end is free to move inside the pipe. Cables are attached to each ring. When the scraper is being pulled by the cable attached to the ring at the right, the upper half of each disk is held perpendicular to the pipe. If the scraper becomes stuck, or for any reason must be pulled back against the stream of water, it can be pulled backwards by the cable attached to the ring at the left, which collapses the upper half of the disks and allows the water to flow past the scraper.

conclusion that the tubes would very probably be caught on some of the numerous projections or rough spots which undoubtedly occurred at each joint of the sewer pipes, and that they probably were lodged somewhere quite near the hospital. He suggested that he build a scraper (Fig. 1) which could be dragged through the sewer line between manholes and that this be tried in the first few blocks to see if the tubes could be brought into a manhole. This procedure was finally decided upon.

At all times while a scraper, or other object, was being pulled through a section of sewer, the Geiger-Müller tube was suspended in the downstream manhole to detect the approach of a radium tube, and a fine-mesh screen was at all times kept ready to be placed over the outflow opening in the manhole to prevent a tube from being washed into the next section of sewer. Two days were spent in unsuccessful efforts to get the 11-inch (28-cm.) scraper through the block of sewer in front of the hospital, although a wadded-up truck tire chain was pulled through. It was finally decided to build another manhole in the center of the block and to construct a 9-inch (23-cm.) scraper.

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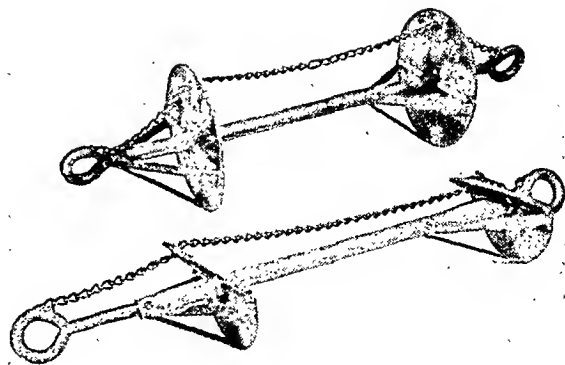


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While these were in course of construction, work was carried on in the next block of sewer. On the first attempt to pull the 11-inch (28-cm.) scraper through, it became stuck and had to be pulled back. The wadded-up truck tire chain was then pulled through and one of the radium tubes came out with the chain; on the next attempt, the 11-inch (28 cm.) scraper was pulled through and the second radium tube was pushed ahead of the scraper. This was on Oct. 15, just six weeks after the tubes had been lost. Both the scraper and the tire chain were pulled through this and the next three blocks of sewer several times, but the third tube was not located.

Since it was possible that the tube might be lodged in a crevice, where it would not be dislodged by anything pulled through the sewer, further blind dragging seemed rather a waste of time. It was decided, therefore, to try to determine definitely whether or not the tube was in a given section of sewer before attempting to clean it. We had considered earlier the possibility of attaching long leads to the Geiger-Müller tube and pulling it through the sewer, but the shortage of suitable shielded cables made that procedure impracticable during war times. Mr. Adrien Porter, one of our mechanics, had suggested putting one of the chambers of the Victoreen minometer in a water-tight housing and pulling that through the sewers, but the minometer did not seem to me to be quite sensitive enough (its sensitivity will be discussed later). Dr. Robert B. Taft (3) had suggested attaching dental films to a cable and allowing them to remain in the sewer long enough to give a definite indication of the presence or absence of the radium. As this seemed to be feasible, tests were made in the laboratory to determine the necessary spacing and exposure time in order to obtain positive results.

The first problem to be solved in order to use the films was their protection from water. Finger cots were considered, but were abandoned because of the scarcity of rubber. The City Engineer's Department had steel rods, 1/4 inch (6.35 mm.) in dia-

meter, which are used to push cutters through the sewers, and it was thought that it might be possible to wrap the films around these rods and cover them with a waterproof covering. For the laboratory tests a tube 30 inches (76 cm.) long and 2 inches (5 cm.) in diameter was filled with water and a tube containing 50 mg. of radium was placed in the bottom. Dental films were wrapped around a piece of glass tubing and covered with two layers of waterproof adhesive tape with a layer of electrician's friction tape between. After twenty-four hours' immersion in water the films were still dry. The tests showed that with Eastman Radia-Tized dental film a spacing of not more than 2 feet (61 cm.) between film, and with Eastman Super Speed Occlusal film a spacing of not more than 4 feet (1.2 meters) between film, with an exposure of twenty-four hours, would be necessary in order to make sure of detecting the tube of radium. The time involved in attaching the film, allowing for the twenty-four hours' exposure, removing, developing, and inspecting the film, seemed rather long should it prove necessary to inspect 2 miles (3.2 kilometers) of sewer. Also, should one film be damaged, that section of sewer would have to be rechecked. Our next idea was to obtain 8-mm. motion picture film, thread it inside ordinary garden hose in a dark-room, plug the ends of the hose, and draw the hose into the sewers. Since with this method the radium tube could not be more than a few inches from the film, a much shorter exposure time could be used.

Before we got around to testing the film-in-hose idea, Mr. Jacobs, one of our mechanics, who had been alternating with me in operating the Geiger-Müller counter, suggested using our Lauritsen electrometer (1). A piece of iron pipe (Fig. 2), 2 1/2 inches (6.35 cm.) inside diameter and 12 inches (30.5 cm.) long, was fitted with a cap at each end. A short piece of 3/4-inch (19-mm.) pipe was welded onto each cap for attaching cables or the steel rods so that the assembly could be pulled or pushed through the sewers. The

electrometer was put inside a piece of rubber stocking to protect it from moisture in case one of the caps on the pipe did not fit tightly, a piece of felt was wrapped around it to make it fit snugly inside the pipe, and disks of sponge rubber placed at either end and a strip of sponge rubber wrapped around the microscope tube were used to help absorb mechanical shocks.

rate of not more than 10 feet (3 meters) a minute should prove quite definitely whether or not the lost tube of radium was in a given section.

Similar tests made with the 0.01 r chamber of the Victoreen minometer showed that it was only about a fifteenth as sensitive as the electrometer, and hence to prove the presence or absence of the radium it

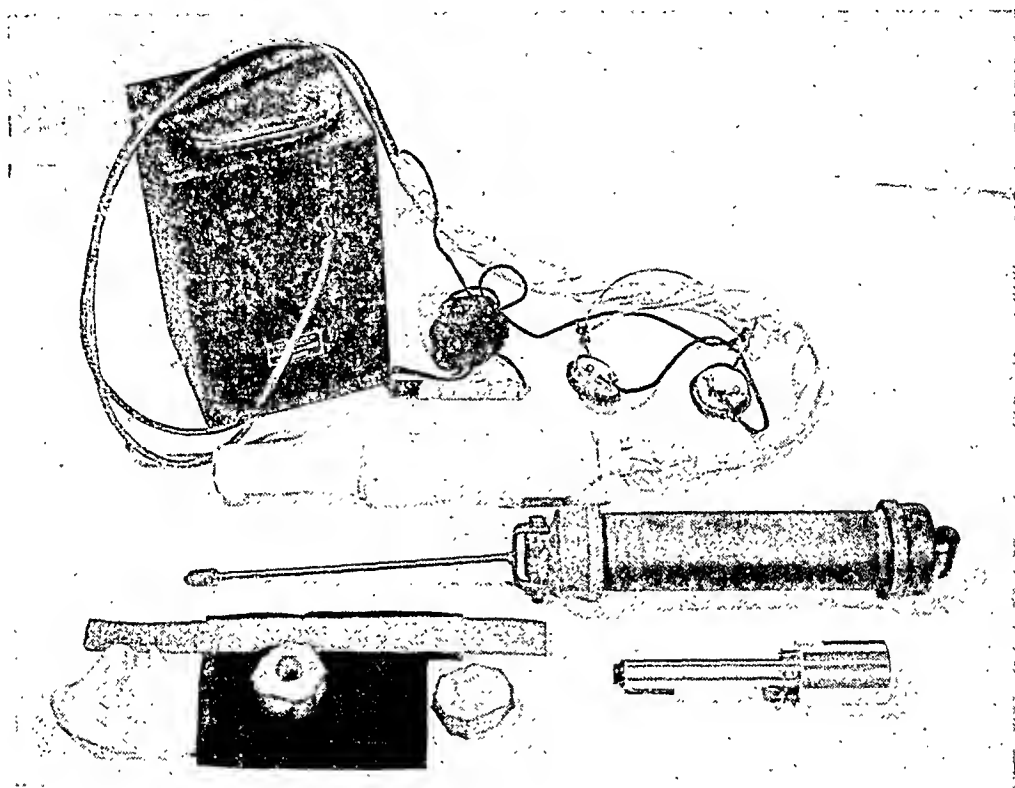


Fig. 2. Portable Geiger-Müller counter (top), with chamber and part of cable covered with a rubber stocking for immersion in water, and extension cable for headphones so that chamber and control box could be lowered into sewer manholes. Lauritsen electrometer (lower right), iron pipe with caps in which electrometer was pulled through sewers, and material used for packing electrometer inside pipe.

Dragging the pipe with the electrometer inside over the laboratory floor for half an hour discharged the electrometer about two divisions (full scale was 100 divisions); dragging it, at a rate of 6 feet (1.8 meters) a minute, past a tube containing 50 mg. of radium shielded by a minimum of 4 inches (10 cm.) of water and with a minimum distance of 10 inches (25 cm.) between radium and electrometer, produced a full scale discharge. This indicated that dragging the electrometer through the sewer at a

probably should be pulled at a rate of not more than 1 foot (30 cm.) a minute.

The first actual use of the electrometer was to test the sewer line from the hospital to the street. No indication of the radium was found. As the line from the hospital apparently joined two sewer lines in the street and these two lines were connected with each other in the middle of the block, the first half block of each of these lines and the line connecting them were next tested. In none of these tests did the electrometer

show a greater discharge than would be expected because of the natural leak of the instrument. The first trip through the next half block of sewer completely discharged the electrometer. Further tests showed that when it was pushed in a distance of 24 feet (7.3 meters) from the farther manhole there was no discharge, but when it went in a distance of 30 feet (9.1 meters) there was a complete discharge. As intermediate distances were not tried, it is not known how accurately the position of the tube of radium could have been determined.

The 11-inch (28 cm.) scraper could be pulled through this section of sewer only to the approximate location of the tube of radium. Beginning at this point there was a deposit, which looked like coal dust, about 2 inches (5 cm.) thick in the bottom of the sewer, which had caught the third tube of radium, although the other two tubes had passed over it. The deposit was packed too tightly to be cleaned out with the larger scraper. After the tire chain and the 9-inch (23 cm.) scraper had been dragged through several times, removing part of the deposit, the 11 inch (28 cm.) scraper was finally pulled through and the tube of radium came with it. This was on Oct. 27, fifty-four days after the tube had been lost.

Electroscopes and Geiger-Müller counters have been used by several searchers in the past to locate radium in sewer lines but, as far as is known, this is the first time such an instrument has been pulled through a sewer. If a sewer is located near the surface of a street, or in a tunnel through which one can carry instruments, the search may be mostly a matter of time. However, as pointed out by Taft (2), the material between the instrument and the radium is of great importance. One foot (30 cm.) of water is equivalent to about 1 inch (2.5 cm.) of lead, 1 foot of earth to about 1 1/2 inches (3.8 cm.) of lead, and 1 foot of concrete to about 2 inches (5 cm.) of lead, and each half inch (1.3 cm.) of lead reduces the intensity of the gamma radiation by about 50 per cent. If a quantity of

radium similar to that which has been lost is available, it may be very worth while to put it in some of the places where the lost radium might be and see if the instruments being used will detect its presence. The shielding power of walls or floors may be surprisingly great.

It is possible that in the search described here the counter might have shown a count slightly higher than the background if held in the street directly over the radium. But to have tested even a block of sewer in this manner, in which the count would not have been increased by more than a few per cent, would have been a tedious and time-consuming job; either of the film methods or the use of a minometer chamber would have been quicker, less time-consuming, and more certain. The film method suggested by Taft or the use of motion picture film in a hose should give satisfactory results and, for testing short lengths of sewer, might be the quickest method, since all the necessary materials would probably be readily available. The spacing of small films and the necessary time of exposure would depend on the amount of radium being looked for; these factors might best be determined by preliminary laboratory tests. The only advantage of an electrometer, such as was used in this search, over a minometer chamber is that the dragging speed for the electrometer can be much greater than for the minometer. A minometer, however, might be more readily available in a radiologic department than a suitable electrometer. Again, when any instrument of this type is used, one should first make preliminary tests, using a quantity of radium similar to that being sought, to determine the maximal speed at which the instrument can be moved.

Mayo Foundation, Rochester, Minn.

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# X-Ray Therapy in the Army<sup>1</sup>

JOHN L. BARNER, Major, M.C.

Atlanta, Ga.

X-RAY THERAPY in the Army, as a unit, is a problem beyond an individual's limits for discussion. Because of the rapid changes taking place in Army organization, and the unforeseen circumstances that may arise, one is not in a position today to discuss the single field of any medical department. We are in a stage of streamlining, brought about by a new type of warfare, the world-wide dissemination of power, the wide range of battles, and the depth of front line defense. This increases the problems of medical care, of the transportation of patients, and the more rapid and better treatment of casualties.

Because of difficulties encountered in obtaining statistical data on new developments, and the limitations inherent in a discussion of what may take place in the future, it is far better to describe what the situation has been and what we may care to strive for in the future. For these reasons this presentation will outline what is taking place at one of a number of General Hospitals in the Army and the interest of the Army in affording its personnel adequate radiation therapy.

The rapid expansion of the standing Army of a few years ago, of several hundred thousand men, to that of today, numbering 5 to 10 million, requires changes in all departments and facilities for more extensive medical care. Many new hospitals have been established, not all of which, however, are as completely equipped as others. This is because the primary concern of the complements of the Army in war is traumatic surgery and general medicine. Cases requiring special care are transferred to General Hospitals strategically placed throughout the United States.

X-ray therapy is practised to some extent throughout the whole Army Medical Department, regardless of where the components may be located. In the field of combat, however, it is not generally encountered, as there the treatment of conditions requiring prolonged hospitalization is not to be expected.

The x-ray machine now designed for use in the zone of combat, and where fixed installations are not possible, is a portable roentgenographic unit which may be used also for superficial x-ray therapy, as for infections and dermatoses. Some of the infections which may be encountered in combat zones are gas gangrene, aerobic cellulitis, including erysipelas, subcutaneous abscesses, carbuncles, furuncles, lymphogranuloma venereum, lymphangitis and lymphadenitis. Dermatoses which might be considered for x-radiation therapy include acute folliculitis, pyogenic or mycotic sycosis, acute dermatomycosis, acute eczemas characterized by intolerable pruritus, and herpes. It is not reasonable to assume that superficial neoplasms should be treated in the field, although such treatment could be given if no other facilities were available.

The large majority of cases requiring x-ray therapy reach the General Hospitals, where there is every facility for proper treatment, where most of the modern conveniences for the patient's comfort are available, and where the length of hospitalization depends upon the progress of the case. Here are seen the cases comparable to those observed in clinics and offices, and the problems are those of the surgeons, the medical men, dermatologists, and other specialists. At the writing of this paper there are seven Army General Hospitals within the continental United States and two outside the United States, in which both deep and superficial x-ray

<sup>1</sup> Presented before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

therapy are available: Letterman General Hospital, William Beaumont General Hospital, Gorgas General Hospital, Tripler General Hospital, Brooke General Hospital, Fitzsimmons General Hospital, Army and Navy General Hospital, Lawson General Hospital, and Walter Reed General Hospital. Radium, too, is available at Letterman General Hospital, Army and Navy General Hospital, Gorgas General Hospital, and Walter Reed General Hospital. In addition, 1,000 mg. of radium, purchased years ago by Army funds, were entrusted to the Howard Kelly Institute, of Baltimore, with the understanding that Army personnel might be treated there.

At Lawson General Hospital, one of the later General Hospitals to include facilities for x-ray therapy, the service is divided into diagnostic and therapy departments, which are housed in adjoining buildings. Here there is apparatus for superficial therapy in the peak range of 140 kv. and deep therapy equipment with a capacity of 220 kv. The therapy department is housed in well lighted air-conditioned rooms. The office and superficial therapy room are combined, while the deep therapy and controls are in separate rooms. Inasmuch as the department was planned before the building of the hospital, it was our good fortune to have everything built according to the latest recommendations of the National Bureau of Standards and the International Roentgen Ray Committee on X-ray Protection. The department has also been supplied with adequate equipment and supplies necessary for treatments, and the various adaptors and cones for the machines. The measurement of the ionization output from the machine is checked at frequent intervals, and a Victoreen Constancy meter is employed during the course of the treatments as a check on proper filtration and operation of the machine.

The superficial therapy section has been in operation since the hospital was officially opened in July 1941, but the deep therapy installation was not completed until February 1942. Since July 1941 there have been 6,468 admissions to

the hospital, including 316 cases for either deep or superficial treatment. A total of some 4,500 treatments<sup>2</sup> of one type or another have been given. The x-ray therapy department must, under the tables of organization, give all radiation administered in the hospital, and for this reason dermatological patients lead the list, constituting about 30 to 50 per cent of all those treated. The remainder of the cases are from the medical, surgical, nose and throat, genito-urinary, neurological, and plastic surgery sections. These remaining cases are chiefly the lymphomatous diseases (including Hodgkin's disease), bone tumors, neoplasms of kidney and testis, parotid tumors, and a few laryngeal, oral, and labial cancers. A few carcinomas and sarcomas of other types are observed from time to time, including melanosarcoma, rhabdomyosarcoma, intracranial tumors, reticulum-cell sarcoma, synovioma, Peyronie's disease, adamantinoma, as well as nonmalignant conditions such as arthritis and bursitis. It might be interesting to note the number of cases of leukemia and Hodgkin's disease seen, for although we are not in a position to make a definite statement, and no statistics are available, the impression is that we see more of these cases than are seen on the outside in the same age groups. There may be a fallacy in this observation, in that we obtain our cases from a wide range of concentrated camps and station hospitals, the complement number of which we are unable to determine and cannot estimate for several years hence. The question has arisen whether there is any relationship between exposure to the hardships of military service and the incidence of these diseases; also as to the part immunization against certain infections may have in producing a so-called "shock" to the hemopoietic system in certain individuals with a predisposition to the blood dyscrasias. This should bear further investigation and research, as also the relationship between trauma and bone tumors.

<sup>2</sup> Since this paper was read some 10,000 more treatments have been added to this number.

The great need for x-ray and radium therapy in the Army is evident if we review the statistics given in the last Annual Report of the Surgeon General (for the fiscal year ending June 1940). The surgeon of each military station or command renders a monthly report of the sick and wounded. From such reports the Surgeon General derived the information used as the basis of calculation of morbidity and mortality rates for the year 1939. In that year the Army numbered 191,551, and there were 81 cases of cancer, with 36 deaths, and 390 cases of non-malignant tumors. The annual admissions rate per 1,000 for officers and enlisted men was 0.4 for cancer and other malignant tumors, and 2.0 for non-malignant tumors. For cancer there was an average loss of 114.2 days per case, or a total of 9,252 days. In this same report the strength of the Army Nurse Corps was given as 684, with an incidence of 5.85 per 1,000 for cancer and other malignant tumors and of 7.31 per 1,000 for non-malignant tumors.

From these figures we may foresee the vast number of malignant neoplasms to be expected when the Army is expanded to 5 or even to 10 million, though the rate would probably no longer be the same, because of the wider range of ages and the methods of selection. In an Army of 5 million men we would expect between 2,000 to 3,000 cases of cancer and 9,000 to 10,000 cases of non-malignant tumors. Because of the close observation of patients in the Army, which is not possible in civilian practice, many cases are seen earlier, with the result that the disease is

more frequently arrested and the men can return to duty.

Now for the first time the Army will have a complement of women about equal to our standing Army before our entry into the war. This additional strength will be made up of the Army Nurse Corps and the Women's Army Corps. Many cases of cancer in this branch of the service, especially those referable to the breast and genito-urinary tract, will fall to the care of the Medical Department of the Army. This may mean the addition of more x-ray therapy departments to certain General Hospitals; certainly it will mean an increase in the allotment and establishment of more centers for radium treatment.

Patients suffering from cancer and allied diseases, few as compared to battle casualties, must be cared for, and the problem of their treatment is primarily one that should interest the radiologist. Here, in an army of millions, can be practised the principles of "early recognition and early treatment."

A disease so prevalent as cancer, with a mortality rate surpassed by only one other condition, must be controlled. The part the radiologist plays, whether in the Army or civilian practice, has much to do in this control; for no matter how meager the contribution, the concerted efforts will eventually produce results.

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## CASE REPORTS

### Roentgen Evidence Suggesting Enterocolitis Associated with Prolonged Cathartic Abuse<sup>1</sup>

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The following case is reported because of the extensive changes in the lower part of the small bowel and throughout the large bowel observed in routine gastro-intestinal studies. As far as can be determined, the etiological factor was the continued and abundant daily use of irritant cathartics for twenty years prior to the roentgenological examinations. A search of the literature has failed to reveal any other case presenting similar changes, although reference is made to catarrhal colitis resulting from overdosage or continued cathartic abuse from irritants (1, 2).

#### CASE REPORT

The patient was a multiparous white female, thirty-six years of age, who for many years had complained of bloating and a feeling of general fullness in the abdomen. She believed that she could not be comfortable without complete evacuation every day. To insure this she had taken proprietary cathartic tablets, the active ingredients of which are phenolphthalein, aloin, and podophyllum, almost daily for the preceding twenty years, *i.e.*, from the age of sixteen until December 1940. This resulted in from two to three watery stools daily, generally in quick succession, producing a feeling of well-being in the abdomen and a sense of complete emptying of the bowels. There had never been involuntary diarrhea. The stools contained mucus at times, but pus and blood were never observed. Unless cathartics were taken the patient experienced constipation, and she never allowed herself to go without an evacuation for more than forty-eight hours without resorting to their use.

In July 1932, the patient had an attack of cramp-like pain in the right lower quadrant lasting for several days, which her attending physician thought was possibly due to appendicitis. An abdominal exploration revealed thickening of the terminal ileum and cecum up to the junction of the cecum and ascending

colon. Here a constricting band was found, which was separated. The appendix was removed and microscopic examination showed subacute appendicitis. There was no evidence of specific or non-specific granuloma. No biopsy specimen was taken from the thickened bowel but the surgeon and those who subsequently observed the case felt that a hyperplastic tuberculous process was probably present.

During the entire twenty-year period there had been no persistent loss of weight, and the patient's general health and nutrition had been relatively good. Her general complaints did not vary to any extent. Because of fear that there might be some organic basis for them, a gastro-intestinal study was made on Nov. 18, 1938. The findings in the upper tract were fairly normal as far as the lower jejunum. The upper jejunum showed slight dilatation (Fig. 1). There was delay in passage of contents through the lower ileum, as it took five hours and a half for the head of the test meal to reach the cecum. The appearance of the terminal ileum and large bowel at seven hours is shown in Figure 2. The mucosal pattern in the terminal ileum is entirely gone and it has a rigid, tube-like appearance. On palpation, the terminal ileum and cecum could be moved about without causing pain. No mass corresponding to their outline could be felt. The colon was narrowed, spastic, and completely lacking in haustrations, presenting a picture similar to that seen in severe colitis. There were no dilated loops of large or small bowel which could reasonably explain the symptoms of bloating and fullness. It is to be noted that the shortening at the flexures and in the sigmoid region is not quite as great as is usually seen with this degree of involvement from a true colitis. Figures 3A and 3B were obtained following barium and air injections into the large bowel. The complete lack of haustrations is striking, but more important is the degree of distensibility, which precludes the possibility of organic thickening of the musculature of the bowel wall from chronic inflammation. The air study shows the mosaic appearance of the mucosa resulting from edema. It would seem, from the history, that the roentgen findings of enterocolitis were the result of excessive catharsis rather than infection. The clinical findings were in close correlation. The patient was advised to discontinue the use of cathartics and a course of treatment was outlined for her.

A year later, in October 1939, another complete gastro-intestinal study was made and the findings were approximately the same as those illustrated. The patient had not altered her regimen in any way during this interval. A year after this she entered the Buffalo General Hospital for study and treatment, which lasted from Nov. 22 to Dec. 4, 1940. Her physical and nutritional states were good. The

<sup>1</sup> Accepted for publication in June 1943.

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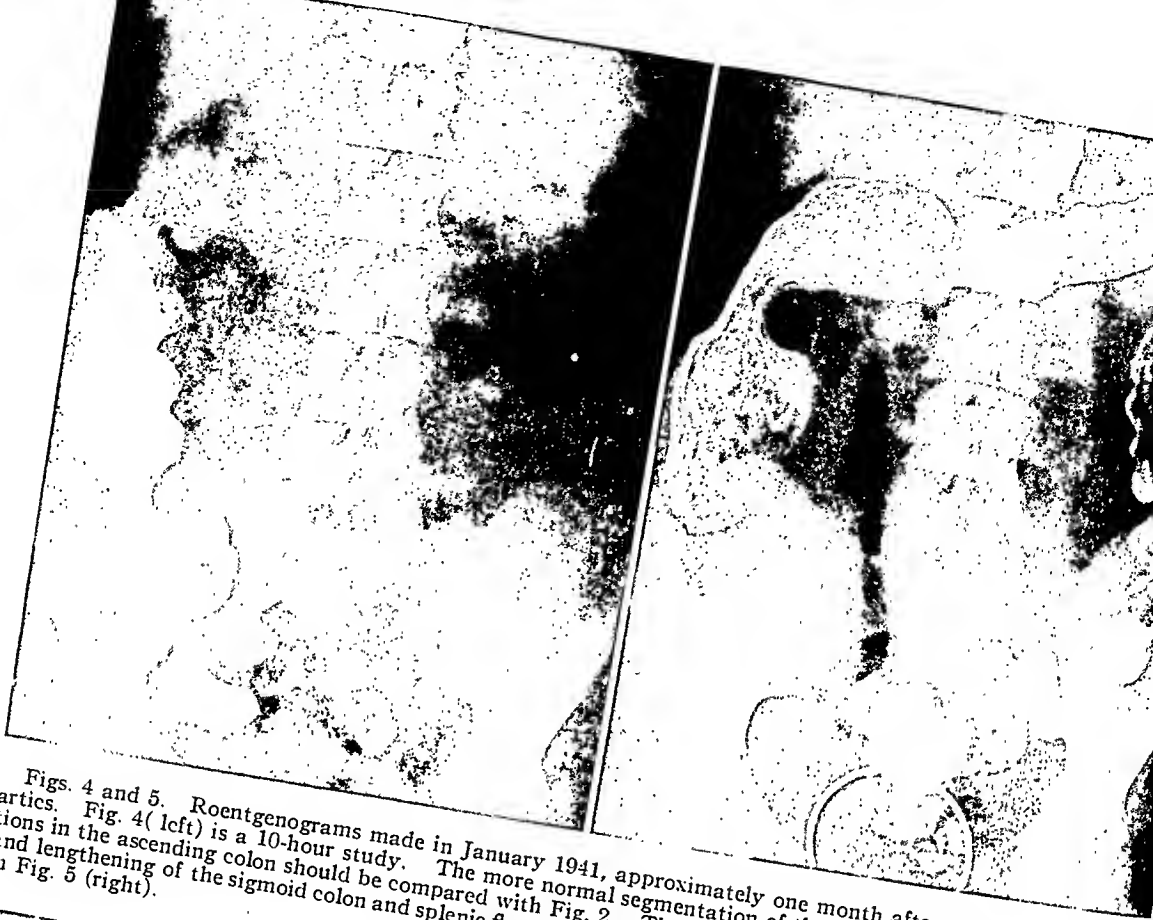


Figs. 1 and 2. First studies made on Nov. 18, 1938. Fig. 1 (left), taken at 1 hour, shows slight dilatation of the jejunum and widening of the folds. In Fig. 2 (right), taken at 7 hours, the lack of normal markings in the terminal ileum and the pipe stem appearance of the colon are well illustrated.



Fig. 3. Barium enema studies before and after air insufflation, Nov. 19, 1938. The lack of haustrations throughout the bowel (A) and the mosaic appearance of the cecum and descending colon (B) are seen, as well as the degree of distensibility present in both.





Figs. 4 and 5. Roentgenograms made in January 1941, approximately one month after cessation of all cathartics. Fig. 4 (left) is a 10-hour study. The more normal segmentation of the terminal ileum and the haustrations in the ascending colon should be compared with Fig. 2. The haustral segmentation of the descending colon and lengthening of the sigmoid colon and splenic flexure are shown also in the 24-hour roentgenogram reproduced in Fig. 5 (right).



6. Barium enema studies before and after evacuation, Jan. 6, 1941. The spasticity of the cecum and abnormality of the mucosal pattern of the descending colon are still present.

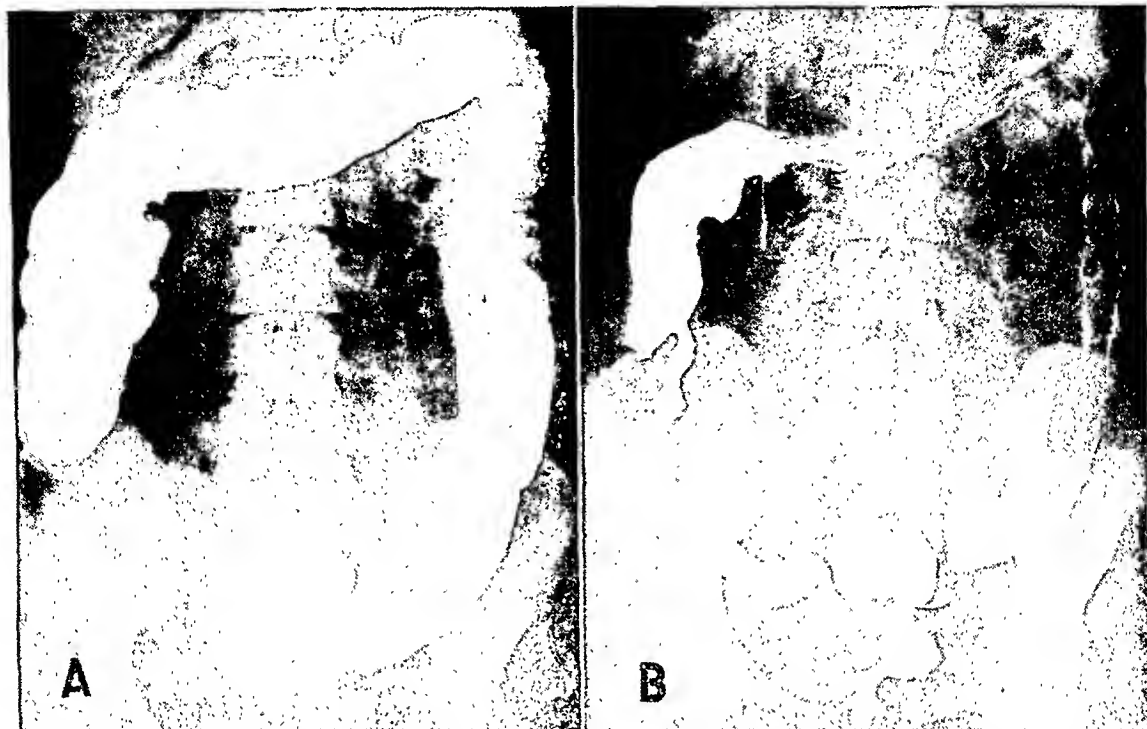


Fig. 7. Barium enema studies before and after evacuation, April 16, 1941, approximately five months after cessation of drastic catharsis. There is slight improvement, but the spasticity of the cecum is still apparent. The mucosal pattern of the descending colon also remains abnormal.

blood, urine, and stool examinations showed no abnormalities except for some increased mucus in the stools. Sigmoidoscopic examination revealed some edema and hyperemia of the mucosa but no evidence of scarring or fixation due to previous acute or chronic ulceration. Upon admission, all irritant cathartics were stopped and the patient immediately felt uncomfortable and distressed. Abdominal distention was marked and various measures for its relief were resorted to, such as enemas, hot stupes, mineral oil, and occasionally pituitrin. Nutritional requirements were well controlled with a smooth diet, added bulk, and vitamins. After a few days some evacuation became possible without accessory means. On discharge the patient was advised to use a suppository and, if this was not successful, to follow it with a plain warm water enema. Subjective symptoms of fullness and bloating continued but there was no noticeable distention.

Another complete study was made on Jan. 4, 1941, a month after discharge from the hospital. During this interval the patient had adhered to the prescribed regimen. There was still a considerable delay in the passage of barium through the ileum but its appearance had improved markedly. The head of the meal did not reach the cecum for seven hours. Figure 4, a ten-hour film, shows segmentation and slight dilatation of the terminal ileum; peristalsis was observed under the fluoroscope. Figure 5 is a 24-hour film showing haustrations in the distal half

of the bowel with less shortening of the flexures than was previously noted. The barium clyisma (Fig. 6A) showed haustrations throughout the colon, less marked in the proximal part. Fluoroscopically it was noted that the cecum filled out normally but had a tendency to be spastic and irritable. This is well illustrated in the post-evacuation film reproduced in Figure 6B.

The patient remained on the suggested regimen for two months but never obtained complete freedom from symptoms, even though the enema and suppositories produced fair evacuation. She never felt that her bowels were adequately emptied. Accordingly, she began to take, from two to three times a week, a bulk proprietary preparation which contained an irritant cathartic, senna. Approximately two months later, on April 16, 1941, a colon study was made. The terminal ileum filled and presented about the same appearance as at the previous examination (Fig. 5). During the filling the large bowel, especially the proximal half, was moderately spastic but finally relaxed so that, in general, the appearance was thought to show slight improvement over the previous examinations. The continued irritability and spasticity were considered as probably due to the senna. Figures 7A and 7B are the enema and post-evacuation studies, respectively.

The patient's general condition has remained unchanged up to the present time. Since July 1941, she has been taking a tablet containing aloin, ex-



Fig. 8. Barium enema study made on Nov. 1, 1941, approximately eleven and a half months after the cessation of drastic catharsis. The distal half of the colon presents a more normal appearance.

tract cascara, and podophyllum, from one to two times a week, and is fairly comfortable. She states that omission of the cathartic results in discomfort. Another complete examination, both orthograde and retrograde, was carried out on Nov. 1, 1941. There was still delay in passage of the test meal through the small bowel, as it took from seven to eight hours for the head of the meal to reach the cecum. The appearance of the ileum was approximately the same as in the previous examination, Jan. 4, 1941. However, the haustrations of the distal half of the colon from the splenic flexure to the rectum, as shown by clysmas, appear to be more nearly normal than at any previous time (Fig. 8).

#### DISCUSSION

In view of the rather good clinical state of the patient over the period of years during which extensive changes were revealed by the gastro-intestinal studies, it seemed probable that these changes were due to the excessive catharsis rather than to inflammatory changes in the bowel wall resulting from an infectious agent. All of the clinical and laboratory observations seemed to support this idea. The only adequate proof available, however, was

the therapeutic test of stopping all cathartics over a period of time. Shortly after their discontinuance the patient became very much more uncomfortable, which would seem to substantiate the conclusion reached. Much more significant, however, was the improvement in the intestinal pattern shown in roentgen studies made approximately one month later (Jan. 4, 1941). It is interesting to note that, although the pattern showed improvement, the transit time of the barium through the small intestine did not return to normal. This delay may perhaps explain the good nutritional state of the patient over a period of many years, in spite of the pronounced changes in the mucosal pattern. There may have been interference with the absorptive function of the mucosa, but it is possible that this was compensated by the prolonged transit time.

The active ingredients of the proprietary preparation used so excessively were podophyllum, aloin, and phenolphthalein, which are classified as irritant cathartics (3). Podophyllum is the most irritant of the resinous cathartics and its action is chiefly on the small intestine. Aloin is a glucoside which on hydrolysis yields an anthraquinone derivative. It is the most irritating of the emodin cathartics, which act chiefly on the large intestine. The last drug, phenolphthalein, exerts its action mostly on the large intestine, but also increases the motility of the small intestine. In addition to its irritating action, it is said to stimulate directly the motor activity of the bowel. Thus the character of the cathartics used and their sites of action would seem adequate to explain the roentgen changes persistently found. The excessive irritation of the mucosa and the motor stimulation of the nerve endings could probably produce edema of the mucous membrane, excess activity of the mucous glands, slowing of the rate of passage through the small intestine, and spasm of the entire tract.

The symptoms of bloating and fullness were never adequately explained by the

roentgenographie findings, because at no time were any dilated loops of bowel seen, nor was there any distention observed clinically except shortly after discontinuance of cathartics. Brown (1) states that the continued use of physies sets up irritability of the bowel wall of two types. These are, first, catarrhal inflammation of the mucous membrane and, second, in the case of the aromatic (emodin) cathartics, irritability of the nerve elements in the bowel wall. Both these changes result in varying degrees of hypertonus and spasm of the muscular wall of the colon with varying degrees of discomfort or actual abdominal pain. When a segment of gut is elamped down in chronic spasm the sensory effect is the same as that caused by over-distention of a normal loop of bowel; hence there may be complaints of fullness, pressure and distention, without any physical evidence of distention. In the case recorded here both effects are probably present because cathartics of both types were used.

The question arises as to whether the failure of the intestinal pattern to return completely to normal between April and November 1941 is due to the presence of permanent irreversible changes in the bowel wall. It seems quite plausible that continuous irritation of the nerve endings and mucosa could bring about some edema and cellular infiltration of the tissues which, if continued over a long enough period of time, might produce permanent changes. Hyperemia and edema were observed proctoscopically. The patient is still using milder cathartics of the same general type, although less frequently. This may offer an additional explanation for the lack of further improvement.

#### SUMMARY

A case is presented in which extensive changes in the small and the large intestine were found in a patient who had used irritant cathartics continuously for twenty years. The roentgen appearance suggested ileitis and colitis. In the absence of the usual signs and symptoms of these diseases,

it seems probable that the intestinal abnormalities were due to the cathartics, since there was rather noticeable improvement in the roentgen appearance shortly after the ingestion of these irritants was discontinued.

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### Calcified Concretions within a Meckel's Diverticulum<sup>1</sup>

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Calcification in appendiceal concretions of sufficient density to produce a visible shadow on the roentgenogram has been described on several occasions. As early as 1908 Seelig (1) reported a case of appendicitis which resembled ureteral calculus because of the presence of a calcified appendiceal concretion in the course of the ureter. Since then Pfahler and Stamm (2), Douglas and LeWald (3), Shelley (4), and recently Jackman (5) have contributed further examples. In 1940 Grevillius (6) reported a case of intestinal calculus which had caused perforation of a Meckel's diverticulum. We have been unable, however, to find in current American literature any case in which the shadows visible on a roentgenogram were proved surgically to represent calcified concretions within a Meckel's diverticulum. Such a case is reported here.

#### CASE HISTORY

On Nov. 18, 1942, a 34-year-old white male was admitted to the Mary Hitchcock Memorial Hospital complaining of nausea and vomiting associated with abdominal pain. The symptoms had begun four days previously, with nausea immediately followed

<sup>1</sup> Accepted for publication in June 1943.



Fig. 1. Roentgenogram of the abdomen showing multiple distended loops of small bowel. In the right lower quadrant are the two irregular shadows of calcification.

by vomiting and a dull aching central abdominal pain. Since the onset the patient had retained nothing taken by mouth and the abdomen had become distended. In spite of multiple daily enemas there had been no bowel movements prior to admission to the hospital. There was no history of previous related symptoms. The patient's family history was non-contributory and his past history revealed nothing except a quite severe chronic rheumatoid arthritis.

The general appearance was that of a thin middle-aged man, acutely ill, holding himself rigidly as he lay in bed. Temperature, pulse, and respirations were within normal limits. Except for the rather severe arthritic deformities involving all the joints, the significant physical findings were abdominal. The abdomen was greatly distended and peristalsis was increased. There were no palpable masses, and rectal examination was negative.

The clinical impression at the time of admission was acute intestinal obstruction (volvulus?, adhesive band?); chronic rheumatoid arthritis.

The only significant laboratory findings were a white blood count rising from 7,200 at 8:45 A.M. to 10,000 at 2:00 P.M. on the day of admission and a slight elevation in the non-protein nitrogen (40 mg. per 100 c.c. whole blood). The latter is easily explained on the basis of the obvious dehydration.

A roentgenogram of the abdomen (Fig. 1) showed multiple distended loops of small bowel, without an

abnormal amount of gas in the colon. A diagnosis of intestinal obstruction was made. In addition, two irregular areas of calcification were seen in the right lower abdomen. These were considered to be most likely calcified nodes, although they were somewhat lower than would be expected. The possibility of gallstones within the lower ileum was considered, but the character of calcification did not favor this diagnosis.

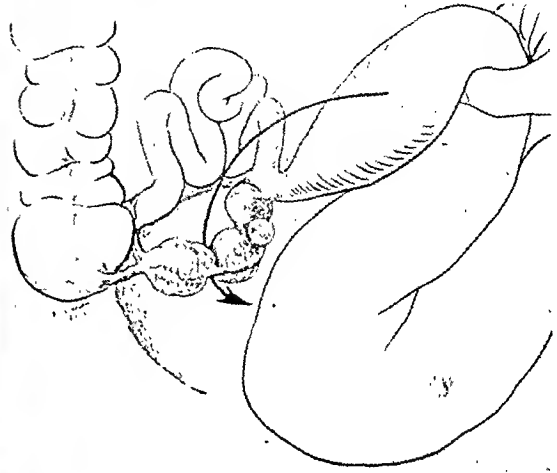


Fig. 2. Drawing demonstrating the mechanism which caused the intestinal obstruction, the Meckel's diverticulum and the appendix together forming a band behind which a loop of ileum just proximal to the diverticulum had become lodged and obstructed.

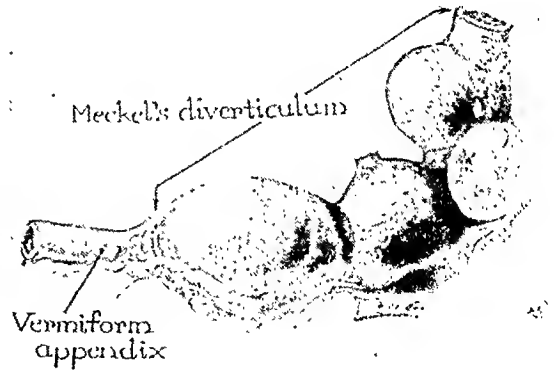


Fig. 3. Drawing of the gross specimen showing the Meckel's diverticulum attached to the tip of the appendix.

Soon after admission fluids were administered intravenously and a Miller-Abbott tube was introduced. In spite of repeated attempts, the tip of the tube failed to pass through the pylorus into the duodenum. At 8:15 P.M. on the day of admission, after observation and treatment had been in progress for twenty hours, it was decided to undertake an exploratory laparotomy. During this time the

patient had received 4,000 c.c. of 5 per cent saline and 500 c.c. of blood intravenously.

At operation a mid-line incision was made and the peritoneum was opened carefully on account of the great distention. There was a moderate amount of fluid in the peritoneal cavity. Exploration revealed a Meckel's diverticulum, arising about 20 inches above the ileocecal valve, which ran down freely, without a mesentery, to the right pelvic wall. At this point its distal end was attached to the tip of the appendix. Together the diverticulum and the appendix formed a band behind which a loop of ileum, just proximal to the diverticulum, had become lodged and obstructed (Fig. 2).

large calcium carbonate fecaliths within the latter.

The postoperative course was satisfactory. The sutures were removed on the tenth postoperative day, and the enterostomy tube on the twelfth day. Fifteen days after operation a small area of bronchopneumonia developed in the left mid-lung field, which responded to chemotherapy (sulfadiazine). The patient was discharged as completely recovered on the twenty-sixth postoperative day.

#### DISCUSSION

Pemberton and Stalker (7) have divided Meckel's diverticula into three clinical

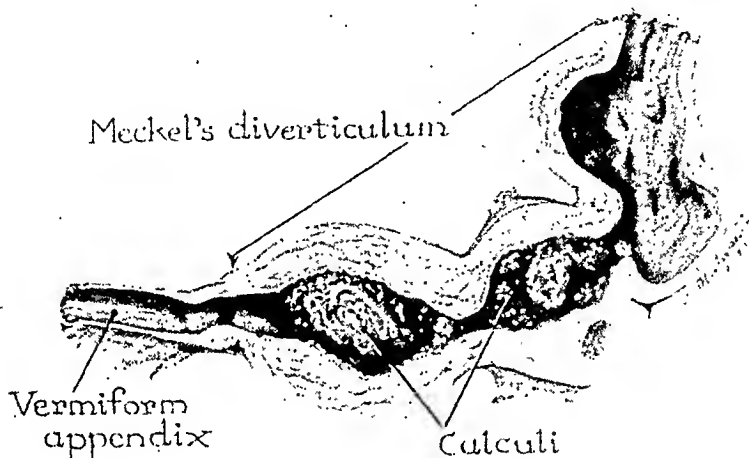


Fig. 4. Drawing of the opened specimen showing the two calcified concretions and the fistula between the Meckel's diverticulum and the appendix.

The main diverticulum came off near the mesenteric border of the ileum. It was doubly clamped at this point and sectioned; carbolic and alcohol were applied to the stump which was buried with a purse-string suture reinforced with interrupted cat-gut sutures. The mesentery of the appendix was clamped and tied. The appendix was removed in the usual manner, so that the whole loop, including the appendix and the diverticulum, was removed as one section of gut. In addition, an ileostomy was carried out through a small left rectus incision.

The pathological staff of the hospital returned the following diagnosis: chronic appendicitis and periappendicitis, chronic Meckel's diverticulitis and peridiverticulitis, Meckel's diverticulo-appendiceal fistula, and calcium carbonate fecaliths.

The artist's drawings depict far better than words can describe the operative and the surgical findings. Figures 2 and 3 show the mechanism which produced the intestinal obstruction and the gross specimen after removal. Figure 4, a drawing of the open specimen, shows the communication between the appendix and the diverticulum as well as the two

groups: (1) those which produce no symptoms and are incidental findings during surgical procedures for unrelated conditions; (2) those which produce intestinal obstruction; (3) those that produce intestinal bleeding. Inasmuch as the intestinal obstruction was the important clinical finding in our case, we have classified it in the second group.

Undoubtedly, cases of this nature have occurred previously. One need only peruse the great volume of literature on Meckel's diverticulum to appreciate that all the pathological entities capable of occurring within any segment of the gastro-intestinal tract have been described as developing here. It is not difficult then to explain the sequence of pathologic events in this case. We believe that appendicitis with ad-

hesions and rupture into the diverticulum laid the ground work for the resultant intestinal obstruction. This would explain the persistent lumen between the two organs. An inflammatory process is a necessary prerequisite to the precipitation of calcium salts upon existing fecal material. The subsequent obstruction made possible by the band-like loop produced by the appendix and the diverticulum led to surgery.

The interesting and unusual part of this picture was the presence of radio-opaque calcified concretions of sufficient density to be visible on the roentgenogram of the abdomen. Our consideration of the differential diagnosis in this case did not include the correct diagnosis. Calcified mesenteric nodes are common at this site and this was our interpretation. Had the patient been a female, calcification within a pelvic tumor would certainly have been considered. It was suggested that these areas might have been gallstones, but there was no gas within the biliary tree, which is often the case under these circumstances (8). The size, shape, and position of the shadows did not suggest calcification within epiploic tags, ureteral stones, or calcified appendiceal concretions.

We know from the history that the patient had not been given barium, nor had he taken any of the known opaque medications.

We present this case because of its unusual surgical, pathological, and roentgenological manifestations, rather than as an addition to the long list of pathological calcifications occurring within the abdominal cavity.

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# EDITORIAL

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John D. Camp, M. D., Associate Editor

## Medical Practice and the Blue Cross

*Per ardua ad astra* was the motto of many knights in the days when chivalry was in flower and did battle with the infidel. *Per ardua ad radiologia scientifica* might be the motto of many physicians and laymen today, men who have been battling the inclusion of diagnostic medical services in group hospitalization plans for almost a decade. These men realize that if a hospital can sell a radiologist's services today, it can sell a surgeon's tomorrow—and, in a short time, can become an advertising, competing corporation selling all branches of medical service. When competition becomes keen, the first thing which can and will be cut will be the quality of medical service. The profession will not dictate the changes; the corporation will.

The trend in government is toward centralization and regimentation. The trend in hospital practice is toward increased control of physicians and increased dictation as to the type of equipment they shall use and even the fees they shall charge. Neither government nor hospital corporation appears to grasp the inevitable results of these trends, which must be the elimination of the personal interest of the physician in his patient and the personal urge for scientific progress.

The new proposed uniform national contract of the Blue Cross Commission specifies the inclusion of radiological services as a part of hospital care. We have no quarrel whatsoever with Blue Cross plans which provide for strictly hospital services in their benefits, but when they attempt to encompass medical services, such as diagnostic radiology, we have a great and keen interest indeed. If the

Blue Cross Plan Commission of the American Hospital Association would revise the wording of its contract, and arrange for the provision of hospital services only, it would comply with the considered recommendations of the organized medical profession and eliminate with one stroke a grave source of friction between the profession and the hospital organizations.

We as radiologists are keenly aware of this problem, but are our colleagues in other branches of medicine? Do they realize that if some branches of medicine are allowed to slip into permanent hospital domination today, almost all branches of medical practice must follow? What can be done about the situation?

*First*, awaken your colleagues to the current state of affairs. Show them the editorials in the *Journal of the American Medical Association* for July 31, 1943 (The Practice of Radiology and Hospital Service Plans), in the Westchester County Medical Society *Bulletin* for August 1943 (Hospital Practice and the Public Interest), and in the San Francisco County Medical Society *Bulletin* for October 1943 (Hospital Control of Medicine).

*Second*, develop the identification of your own practice in your hospital. Your colleagues know that you are trained and skilled in radiology. When they themselves want to have a stomach examination, a "lumbosacral," or a sinus study, they come to you as a radiologist. But too often their patients regard you as an unknown hospital functionary. They will regard you as a radiologist only when you identify yourself as such—both by written and spoken word. Especially important in this connection is the rendering of bills



to private patients in your own name, not the hospital's—or, at least, the imprint of your name on the x-ray statement. Legally and ethically a corporation should not bill for a professional man's services. You will therefore be assisting both your hospital and your profession in emphasizing the identity of radiology as a medical procedure done by the radiologist, and not by a hospital.

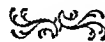
*Third*, give every possible assistance to Blue Cross plans that provide for strictly hospital benefits. Even though not a single Blue Cross plan has been approved to date by the organized medical profession, a few do comply with the major principles of our profession (especially with principle number 4 defining hospital care. See *Journal of the American Medical Association* for June 19, 1943, page 531).

*Fourth*, give every possible assistance to state medical association sponsored (and medically controlled) voluntary Health Insurance or Medical Service Plans. As Dawson of Penn says: "We must innovate greatly but quietly." We must develop better methods of distributing medical services to all the people. But in

so innovating we must not eradicate the quality and standards of medical practice. Else the public gets a hollow shell—a beautiful medical benefits plan *on paper*. As a writer recently observed concerning New Zealand's plan, "the provision of free hospital beds for all sounds very well, but unfortunately there aren't any vacant beds!"

Hospital or government controlled schemes tend to result in the doctor being responsible to the institution or the local political chief, rather than to the patient. Outside of a handful of large teaching or research institutions, this usually means responsibility to some lay board of trustees. When the personal responsibility of the doctor to the patient terminates, the welfare of the latter inevitably suffers. If Blue Cross really desires to provide worth-while medical benefits along with hospital care, it can do so in co-operation with the medical profession by means of joint policies (providing anything from simple diagnostic medical services up to deductible "catastrophic" inclusive medical benefits). But these medical benefits should be furnished by and under the control of the medical profession.

CONTRIBUTED



## ANNOUNCEMENTS AND BOOK REVIEWS

### CANCER TEACHING DAY

Cancer Teaching Day was observed in Poughkeepsie, N. Y., and Olean, N. Y., on Nov. 10 and 11, respectively. In Poughkeepsie the meetings were conducted under the auspices of the Dutchess County Medical Society, Dutchess County Tumor Clinic, the Tumor Clinic Association of the State of New York, the New York State Medical Society, and the Division of Cancer Control of the State Department of Health. The speakers were Dr. Norman Treves, Dr. Lloyd F. Craver, and Dr. Archie L. Dean, of Memorial Hospital, New York City; Dr. Arthur J. Wallingford, Executive Head of the Department of Obstetrics and Gynecology, Albany Medical College and Albany Hospital, Albany, N. Y.; Dr. Maurice Lenz, Professor of Clinical Radiology, College of Physicians and Surgeons, Columbia University, New York City.

The Olean program was presented under the auspices of the Cattaraugus County Medical Society, the New York State Medical Society, and the Division of Cancer Control of the State Department of Health. Dr. Lloyd F. Craver of Memorial Hospital and Dr. Clyde L. Randall, Professor of Gynecology in the University of Buffalo School of Medicine, were the speakers.

### ERRATUM

In the paper on "Fluoride Osteosclerosis from Drinking Water," by Major Joseph F. Linsman, M.C., and Major Crawford A. McMurray, M.C., in *RADIOLOGY* for May 1943, the fluorine content of the drinking water in Spur, Texas, is unfortunately given as 12 parts per million, instead of 1.2 parts per million (Vol. 40, page 474, fifth line of second column).

### CUMULATIVE INDEX 1923-1942

The Editorial Office is happy to be able to announce the completion of the Cumulative Index of *RADIOLOGY*, covering Volumes 1 to 39, 1923 to 1942. The index, which has been in course of preparation for more than two years, covers both original contributions and abstracts and includes both author and subject headings, so arranged as to form a complete guide to the published material of twenty years. The work is now on the press and will shortly be ready for distribution. Further information appears on another page of this issue.

### In Memoriam

ISAR G. FOX, M.D.  
1900-1943

Dr. Isar G. Fox of Harlingen, Texas, died on July 15, 1943, of acute leukemia. Doctor Fox was born in Galveston, Texas, in 1900, was graduated from the University of Texas School of Medicine, and subsequently did postgraduate work at the University of Pennsylvania, specializing in radiology. He was a diplomate of the American Board of Radiology and a member of the Radiological Society of North America.

GEORGE C. CHENE, M.D.  
1882-1943

Dr. George C. Chene of Detroit, Mich., died in September 1943. Doctor Chene was born in Windsor, Ontario. He received his medical education in Detroit and for thirty years was a member of the staff of Providence Hospital in that city. He was a member of the American Roentgen Ray Society and the Radiological Society of North America.

DAVID YANDELL KEITH, M.D.  
1881-1943

Word has been received of the death of Dr. David Yandell Keith, of Louisville, Ky. Doctor Keith was graduated from the University of Louisville in 1909 and was shortly thereafter appointed to the teaching staff, of which he remained a member throughout his life. At the time of his death he was Professor of Radiology. He was a diplomate of the American Board of Radiology and a member of the American College of Radiology and the American Radium and American Roentgen-Ray Societies.

### Books Received

*THE MEDICAL ANNUAL 1943. A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX.* Editors: Sir HENRY TIDY, K.B.E., M.A., M.D. (Oxon.), F.R.C.P., and A. RENDLE SHORT, M.D., B.S., B.Sc., F.R.C.S. Published by John Wright & Sons Ltd., Bristol, and Simpkin Marshall (1941) Ltd., London.

*A HUNDRED YEARS OF MEDICINE.* By C. D. HAAGENSEN and WYNDHAM E. B. LLOYD. A volume of 444 pages, with 42 illustrations. Published by Sheridan House, Inc., New York. Price \$3.75.

# RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please co-operate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit, 2 Mich.

## UNITED STATES

*Radiological Society of North America.*—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse, N. Y.

*American Roentgen Ray Society.*—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

*American College of Radiology.*—Secretary, Mae F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

*Section on Radiology, American Medical Association.*—Secretary, J. T. Murphy, M.D., 421 Michigan St., Toledo, Ohio.

## ARKANSAS

*Arkansas Radiological Society.*—Secretary-Treasurer, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

## CALIFORNIA

*California Medical Association, Section on Radiology.*—Secretary, Joseph D. Coate, M.D., 434 Thirtieth St., Oakland.

*Los Angeles County Medical Association, Radiological Section.*—Secretary, Donald R. Laing, M.D., 65 N. Madison Ave., Pasadena. Meets second Wednesday of each month at County Society Building.

*Pacific Roentgen Society.*—Secretary-Treasurer, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Society meets annually during annual meeting of the California Medical Association.

*San Francisco Radiological Society.*—Secretary, Sydney F. Thomas, M.D., San Francisco Hospital. Meets monthly on third Thursday at 7:45 P.M., in Toland Hall, University of California Hospital.

## COLORADO

*Denver Radiological Club.*—Secretary, Edward J. Meister, M.D., 366 Metropolitan Bldg. Meetings third Friday of each month at the Denver Athletic Club.

## CONNECTICUT

*Connecticut State Medical Society, Section on Radiology.*—Secretary-Treasurer, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings bimonthly, on second Thursday. Place of meeting selected by Secretary.

## FLORIDA

*Florida Radiological Society.*—Acting Secretary, Walter A. Weed, M.D., 204 Exchange Building, Orlando.

## GEORGIA

*Georgia Radiological Society.*—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta. Meetings twice annually, in November and at the annual meeting of State Medical Association.

## ILLINOIS

*Chicago Roentgen Society.*—Secretary, Warren W. Furey, M.D., 6844 S. Oglesby Ave. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

*Illinois Radiological Society.*—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

*Illinois State Medical Society, Section on Radiology.*—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago.

## INDIANA

*The Indiana Roentgen Society.*—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis. Annual meeting in May.

## IOWA

*The Iowa X-ray Club.*—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

## KENTUCKY

*Kentucky Radiological Society.*—Secretary-Treasurer, Sydney E. Johnson, M.D., Louisville City Hospital, Louisville. Meeting annually in Louisville, third Saturday afternoon in April.

## LOUISIANA

*Louisiana Radiological Society.*—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

*Shreveport Radiological Club.*—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at the offices of the various members.

## MARYLAND

*Baltimore City Medical Society, Radiological Section.*—Secretary, Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

## MICHIGAN

*Detroit X-ray and Radium Society.*—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive; at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

*Michigan Association of Roentgenologists.*—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

## MINNESOTA

*Minnesota Radiological Society.*—Secretary, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

## MISSOURI

*Radiological Society of Greater Kansas City.*—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

*The St. Louis Society of Radiologists.*—Secretary, Paul C. Schnoebelen, M.D., 462 N. Taylor Ave. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

## NEBRASKA

*Nebraska Radiological Society.*—Secretary, F. L. Simonds, M.D., 1216 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

## NEW ENGLAND

*New England Roentgen Ray Society* (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—Secretary, Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

## NEW JERSEY

*Radiological Society of New Jersey.*—Secretary, H. J. Perlberg, M.D., Trust Co. of New Jersey Bldg., Jersey City. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

## NEW YORK

*Associated Radiologists of New York, Inc.*—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

*Brooklyn Roentgen Ray Society.*—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave. Meetings held the fourth Tuesday of every month, October to April.

*Buffalo Radiological Society.*—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

*Central New York Roentgen Ray Society.*—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

*Long Island Radiological Society.*—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

*New York Roentgen Society.*—Secretary, Haig H. Kasabach, Presbyterian Hospital, New York, N. Y.

*Rochester Roentgen-ray Society.*—Secretary, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

## NORTH CAROLINA

*Radiological Society of North Carolina.*—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

## NORTH DAKOTA

*North Dakota Radiological Society.*—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

## OHIO

*Ohio Radiological Society.*—Secretary, J. E. McCarthy, M.D., 707 Race St., Cincinnati. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

*Cleveland Radiological Society.*—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

*Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).*—Secretary-Treasurer, Samuel Brown, M.D., 707 Race St. Meetings held third Tuesday of each month.

## PENNSYLVANIA

*Pennsylvania Radiological Society.*—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport. The Society meets annually.

*The Philadelphia Roentgen Ray Society.*—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

*The Pittsburgh Roentgen Society.*—Secretary-Treasurer, Reuben G. Alley, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

## ROCKY MOUNTAIN STATES

*Rocky Mountain Radiological Society* (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—Secretary, A. M. Popma, M.D., 220 North First St., Boise, Idaho.

## SOUTH CAROLINA

*South Carolina X-ray Society.*—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston. Meeting in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

## TENNESSEE

*Memphis Roentgen Club.*—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

*Tennessee Radiological Society.*—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

## TEXAS

*Texas Radiological Society.*—Secretary-Treasurer, Herman Klapproth M.D., Sherman.

## VIRGINIA

*Virginia Radiological Society.*—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond.

## WASHINGTON

*Washington State Radiological Society.*—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

## WISCONSIN

*Milwaukee Roentgen Ray Society.*—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee. Meets monthly on second Monday at the University Club.

*Radiological Section of the Wisconsin State Medical Society.*—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

*University of Wisconsin Radiological Conference.*—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

## CANADA

*Canadian Association of Radiologists.*—Honorary Secretary-Treasurer, A. D. Irvine, M.D., 540 Tegler Bldg., Edmonton, Alberta.

*La Société Canadienne-Française d'Électrologie et de Radiologie Médicales.*—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

## CUBA

*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

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bronchial lymph nodes. Following the most recent survey, in 1941, a complete restudy was made of all x-ray films of children who had been included in two or three of the studies. An unusual finding, in view of the fact that such calcification is usually considered to be tuberculous, was that the incidence of these lesions was only slightly higher among tuberculin-positive than among tuberculin-negative children.

In all, 935 white and 235 colored school children were examined in two of the school studies and some of these were examined on three separate occasions. A review of these serial roentgenograms shows that 83 per cent of the white and 72 per cent of the colored school children had calcified lesions in the lungs or tracheobronchial lymph nodes. The data provided according to age group at the time of first examination indicate that these children acquire pulmonary calcification at a very early age. In the review of the serial films 31 children who had no evidence of calcification on the first examination were found to have acquired it prior to the last film.

Tuberculin tests were completed for 881 white children. Among those with extensive calcification, 15.7 per cent reacted to 0.01 mg.; among those without calcification, but 5.9 per cent reacted to 0.01 mg. Among the colored children the same tendency was noted. No explanation is offered for the unusually high incidence of calcification in these children and its association with tuberculin anergy. L. W. PAUL, M.D.

**Natural History of Tuberculous Tracheobronchitis.** D. Salkin, A. V. Cadden, and R. C. Edson. *Am. Rev. Tuberc.* 47: 351-369, April 1943.

In this report are presented the results of a study of tuberculous tracheobronchitis in a group of 125 consecutive autopsies on patients dying from pulmonary tuberculosis and another group of 622 consecutive admissions to a tuberculosis sanitarium covering the same period of time. In 50 of the postmortem group, or 40 per cent, tuberculous lesions in the trachea and large and medium-sized bronchi were present. The exudative cases presented the highest incidence of tracheobronchitis, followed by the mixed cases and then the fibroid. The high incidence of bronchitis in lower lobe disease was noteworthy. The age of the patient and the duration of the disease were found to be of no significance. The lesions commonly seen included all varieties of ulcers, submucosal nodules, fibrous and inflammatory stenoses.

No symptom or group of symptoms was found to be pathognomonic of tracheobronchitis. Unusually severe cough, variable and copious sputum, and substantial discomfort were suggestive. In the group upon which the clinical study was based, all patients received an initial routine bronchoscopy and in positive cases this procedure was repeated every three to six months thereafter. Of the 622 patients, 64, or 10 per cent, showed a tuberculous lesion on the first examination. Eventually 33 more cases showed positive bronchial findings, making a total of 97, or 15.5 per cent of the group. The changes observed bronchoscopically were classified as non-ulcerative, ulcerative, and stenotic.

The roentgenologic signs in the presence of tracheobronchial tuberculosis are listed as follows: (1) Blocked cavities. These occurred in 6 per cent of the group with normal bronchi and in 9 per cent of those with diseased bronchi. (2) Evidence of bronchial irregularities demonstrable on overexposed films, Bucky films,

tomograms, and bronchograms. (3) Atelectasis or a uniform airlessness of a lung, a lobe, or part of a lobe. Small patchy lobular areas were not included because of the difficulty in differentiating them from true spread. Atelectasis was present in 12 per cent of the negative group and 36 per cent of the positive cases. Its incidence was higher in the clinical than in the autopsy group, possibly due to the fact that by the time the patient died, the previously atelectatic area may have been included in a progressive, caseous, and cavernous process. (4) Bronchiectasis as proved by bronchograms, showing saccules and dilatations large enough to be of clinical significance. Relatively few bronchiectasias were made. In the negative group significant ectasia was present in 43 cases, or 8 per cent, and in the positive group in 14 cases, or 14 per cent. Most of the saccules and dilatations were present at the site of the parenchymal disease, but in about 21 per cent of each group they occurred chiefly distal to the main pulmonary lesion.

In the pathogenesis of tracheobronchial tuberculosis, several factors are important, including the following: (1) most cases of bronchitis occur on the side of the more extensive lesion; (2) the great majority are associated with positive sputum and cavity; (3) the incidence is high in lower lobe disease where sputum drainage is less effective; (4) the incidence of bronchitis increases as one approaches a cavity. Cases with bronchitis show a more severe clinical course and have a poorer prognosis than those in which the bronchi are normal, but if the parenchymal lesion is controlled and inactivated, tuberculous bronchitis will heal spontaneously in about 80 per cent of all patients. L. W. PAUL, M.D.

**Bronchiectasis and Dextrocardia: Observations on the Etiology of Bronchiectasis.** A. M. Olsen. *Am. Rev. Tuberc.* 47: 435-439, April 1943.

The simultaneous occurrence of bronchiectasis and sinus disease accompanying transposition of the viscera has been called "Kartagener's triad." The frequency of occurrence of this syndrome has served as a powerful argument in favor of the theory of a congenital origin of bronchiectasis. It is generally recognized that bronchiectasis and disease of the accessory nasal sinuses are commonly associated.

The observations here recorded are based upon a total of 85 patients who had true congenital dextrocardia, encountered at the Mayo Clinic. Definite evidence of bronchiectasis was present in 14, or 16.5 per cent of this group. In the same period a diagnosis of bronchiectasis was made in less than half of one per cent of the total number of patients who registered at the Clinic. Clinical experience demonstrates that the manifestations of bronchiectasis most often appear after the precipitating factors of bronchial obstruction, atelectasis, and infection. Such influences, however, are more likely to provoke the clinical syndrome in persons whose bronchi are peculiarly susceptible to dilatations than among others. Thus, both congenital and acquired components probably enter into the production of the disease in most instances. L. W. PAUL, M.D.

**Tuberculosis in Industry.** H. R. Edwards. *Am. J. M. Sc.* 205: 571-581, April 1943.

Industry is now operating at its maximum and is, therefore, placing a greater strain on the worker than ever before. This increased strain will result in many

breakdowns of active tuberculous lesions as well as latent or unhealed processes.

The spread of tuberculosis is conditioned in large part by the number of infectious cases in the community. In an examination of over 15,000 union workers in various industries in New York City the incidence of clinically significant disease was found to be 0.61 per cent, of apparently arrested chronic pulmonary tuberculosis 2.92 per cent, and of healed primary lesions 12.43 per cent.

Surveys of this type should be the basis for a program of medical care for the industrial employee which should be the joint responsibility of labor and management.

BENJAMIN COPLEMAN, M.D.

**Pulmonary Fibrosarcoma of the Chest Wall Following Thoracic Trauma.** J. M. Blake and J. K. Bradford. *J. Thoracic Surg.* 12: 368-375, April 1943.

A 20-year-old man gave a history of fractures of the right fifth and sixth ribs at the age of 16 years. These fractures healed and there were no further symptoms until a second injury to the same area 6 months before admission. No roentgenograms were taken at that time. The pain persisted and the patient lost 40 pounds in weight. He had no pulmonary symptoms.

Examination revealed a mass on the anterior lateral aspect of the right chest wall at the level of the fifth and sixth ribs, with a large smooth intrathoracic extension and destruction of the sixth rib. The mass was explored and found inoperable because of soft tissue invasion posteriorly and metastatic thrombosis of a vessel on the chest wall. Radiation therapy (3,900 r in 14 days) had no effect on the tumor. Death occurred twenty-one months after the second chest injury. Autopsy showed a large fibrosarcoma of the chest wall and pulmonary metastases. The most interesting feature was a nodule occluding the right lower lobe bronchus. This bronchial mass had a broad pedicle and, although no mention was made of its histological structure, it is assumed that it was a metastasis.

As usual, it was not possible to establish definitely the relationship between the injury and the tumor. In any case of trauma where symptoms persist after the injury should have healed, a complete examination including roentgenograms should be made.

HAROLD O. PETERSON, M.D.

**Bronchial Adenoma with Metastasis to the Liver.** W. M. Anderson. *J. Thoracic Surg.* 12: 351-360, April 1943.

Until 1937 there had been no report of a bronchial adenoma metastasizing. Since then several cases have been recorded with metastasis to adjacent lymph nodes or showing microscopic metastases in the vertebra or the liver. The authors present a case of bronchial adenoma in a 40-year-old male with a 2-cm. metastasis in the liver. They conclude that bronchial adenomas should be treated like other malignant neoplasms. A general discussion is presented concerning the origin and malignancy of these tumors.

HAROLD O. PETERSON, M.D.

**Bronchial Involvement in Metastatic Pulmonary Malignancy.** D. S. King and B. Castleman. *J. Thoracic Surg.* 12: 305-315, April 1943.

Contrary to the usual belief that metastatic carcinoma does not involve the bronchi, the authors feel that

this occurs quite commonly. They also believe that bronchial obstruction and pulmonary hemorrhage simulating a primary carcinoma of the lung may occur with metastatic tumors, although rarely. They reviewed autopsy records of 109 patients with metastases to the lungs. In 20 of these cases there was evidence of bronchial involvement, either erosion of the tumor into the lumen of a bronchus or metastasis directly to the bronchial wall. Only four of these patients had hemoptysis. In 14 cases the neoplasm was carcinoma and in 6 sarcoma. The authors conclude that a metastatic pulmonary neoplasm may simulate a primary tumor and that hemoptysis cannot be considered as pathognomonic of a primary growth.

HAROLD O. PETERSON, M.D.

**Congenital Cysts of the Mediastinum: Report of Three Cases Including a Gastric Cyst.** H. A. Carlson. *J. Thoracic Surg.* 12: 376-393, April 1943.

This article presents a good short review of congenital cysts of the mediastinum. There are in addition 3 case reports, of a gastric cyst, a bronchial cyst, and a teratoma. Congenital cysts known to occur in the mediastinum, with their sources, are as follows:

- (1) Epidermoid cysts—ectoderm
- (2) Dermoid cysts—ectoderm and mesoderm
- (3) Teratomas—ectoderm, endoderm, mesoderm
- (4) Cystic lymphangiomas—mesoderm
- (5) Pericardial coelomic cysts—mesoderm
- (6) Bronchial cysts—endoderm and mesoderm
- (7) Gastric cysts—endoderm and mesoderm
- (8) Enteric cysts—endoderm and mesoderm

The first three can be grouped together, since they present a similar clinical and roentgenologic picture. They occur in the anterior mediastinum but may become large enough to protrude into both lung fields and also fill the entire mediastinum. They are usually asymptomatic for a number of years, symptoms first developing in the third and fourth decades.

The cystic lymphangiomas, which are less common, are characterized by the formation of multiple cysts. The cysts may occur anywhere and histologic diagnosis is not possible before surgical removal or autopsy.

Pericardial cysts are simple thin-walled cysts located along the apex of the heart, usually asymptomatic.

Bronchial cysts are located in the posterior mediastinum and have a bronchial structure. They obstruct the air passages and produce symptoms early in life. They also cause dysphagia.

Gastric cysts reproduce the structure of the stomach. They may even have a peptic ulcer and 2 cases have been reported with rupture into the lung and fatal pulmonary hemorrhage. The contents can vary from a few to 400 c.c. of milky, clear, amber, or sanguineous fluid, which is either acid or neutral in reaction. These cysts are usually in the posterior mediastinum, behind the root of the lung. If fluid containing hydrochloric acid is aspirated, the diagnosis can be made.

Enteric cysts are very rare and cannot be differentiated clinically from bronchial and gastric cysts. All those reported have been found at autopsy in infants.

HAROLD O. PETERSON, M.D.

**Pathology of Closed Injuries of the Chest.** J. V. Wilson. *Brit. M. J.* 1: 470-474, April 17, 1943.

The author gives a rather detailed discussion—based on postmortem studies—of closed chest injuries such



as are being encountered in the present war. His material is drawn from both military and civilian casualties.

The cases under discussion are divided into two main categories, those due to direct violence to the chest and those resulting from injuries elsewhere in the body. The first group includes lacerations, contusions, and blast injuries, and it is these with which this paper is chiefly concerned. Two cases of laceration due to explosions are presented, both illustrating the seriousness of the condition, which depends not so much on the actual lung injury as upon the development of complications. In both cases there were fractured ribs and a torn lung. Internal complications in this category are listed as pneumothorax, compression or collapse of the lung, and infection.

Under the heading of contusion it is pointed out that injuries to the heart by non-penetrating blows are commoner than is supposed. Trauma to the heart occurs either directly or as a feature of a blast injury. It may cause contusions of the myocardium, traumatic pericarditis, or rupture of the valves of the great vessels. Any part of the myocardium may be involved, but the anterior surface of the ventricles seems more often to be affected, the injury being frequently followed by local hemorrhage and eventual softening, which follows the same course as infarction. Traumatic pericarditis is rarely serious, and valvular injuries and rupture of the great vessels are not common. One case of pulmonary contusion is described in which direct trauma affecting the upper part of the lung caused hemorrhage throughout the lobe involved.

In blast injuries hemorrhagic areas are scattered throughout the lung, deep in its substance as well as subpleurally. Histologically the lungs of patients dying early show widespread congestion and intra-alveolar hemorrhage. Since changes may not be limited to the lungs, it is important that all cases of blast be examined with a consideration of cardiac symptoms also, as tachycardia, dilatation, and irregularity.

Pulmonary fat embolism is given as an example of chest injuries secondary to trauma elsewhere. It is usually a sequel to fracture of a long bone, notably the femur.

Q. B. CORAY, M.D.

## THE DIGESTIVE TRACT

Considerations on the Diagnosis of Large Gastric Ulcers and Implications as to Treatment. F. Steigmann. *Am. J. Digest. Dis.* 10: 88-93, March 1943.

From a study of over 200 large gastric ulcers, the author has come to a realization that "there are no symptoms, signs, laboratory tests, x-ray or gastroscopic findings, which will determine the nature of a large gastric ulcer." X-ray findings are 95 per cent correct in the diagnosis of peptic ulcer, but in the case of large gastric ulcers, those thought by roentgenologists to be benign may be malignant and *vice versa*.

Checking on some current theories of diagnosis, Steigmann has found that duration of symptoms is not necessarily of diagnostic importance. The age of the patient is of little help. Eighty-two per cent of the patients having benign ulcers were over forty years of age and there were several instances of carcinoma below forty. Vomiting, weight loss, pain, blood in the stools could not be relied on for a differential diagnosis. Free acid was sometimes present in carcinoma of the stomach. Many patients having benign ulcers showed

free acid below 20 degrees and only 30 per cent had a free acid value above 40 degrees.

The x-ray signs usually described as differentiating a benign from a malignant ulcer—namely, size (ulcers larger than a quarter being probably malignant), location, rugal pattern, an incisura opposite the ulcer, pylorospasm, pain on pressure—all fail as diagnostic criteria in the presence of a large gastric ulcer, mainly because of the distortion produced by the lesion.

It has been said that no criteria are pathognomonic of a benign lesion unless it be the roentgenologically and gastroscopically observed and proved complete healing of the ulcer. The author agrees with the first part of this statement but takes exception to the latter, reporting a case to prove his point.

JOSEPH T. DANZER, M.D.

Prolapsed Gastric Mucosa: Roentgenologic Demonstration of Ulcer Crater in Prolapsed Polypoid Mucosa. A. Melamed and R. I. Hiller. *Am. J. Digest. Dis.* 10: 93-95, March 1943.

A case of prolapsed gastric mucosa with ulceration of the prolapsed portion was demonstrated by roentgen examination. The findings were proved at operation.

JOSEPH T. DANZER, M.D.

Jejunal Diverticula: Consideration of Clinical Symptomatology and Case Report. A. C. Van Ravenswaay and G. W. Winn. *Am. J. Digest. Dis.* 10: 108-111, March 1943.

According to Johns, writing in 1937 (*South. Med. & Surg. J.* 99: 265, 1937), there had then been recorded in the literature only 26 cases of jejunal diverticulum discovered by x-ray examination, of which 17 had been verified at operation.

The cause of these diverticula is not known, some appear in young infants, indicating the probability of a congenital origin. Those seen in later life are thought to be due to a congenital or acquired weakness of the abdominal wall. The symptoms resulting from distention of the sac are usually described as a feeling of fullness, although there may be dull or acute pain and localized tenderness. Acute jejunal diverticulitis is prone to lead to gangrene and rupture, and unless there is prompt surgical intervention fatal termination may be anticipated.

A case is reported.

JOSEPH T. DANZER, M.D.

Bleeding Associated with Extramucosal Tumors of the Stomach. O. D. Sahler, and A. O. Hampton. *Am. J. Roentgenol.* 49: 442-449, April 1943.

The term "extramucosal tumors of the stomach" is used to include a large variety of histopathologically different tumors, including leiomyoma, fibroma, neuroma, hemangioma, aberrant pancreatic tissue, and the malignant forms of some of these lesions. On roentgen examination these tumors must be differentiated from cancer and benign polyps. Differentiation from cancer depends upon the relative normality of the adjacent mucosa, the sharpness and smoothness of outline, and the angle formed at the gastric wall junction, which is usually obtuse, though it may be acute. The most common distinguishing feature in differentiation from polyps is that these tumors are usually sessile, whereas polyps are often pedunculated. Additionally, the contour of the extramucosal tumors is relatively smooth as contrasted with the more lobulated appearance of

polyps; ulceration of the deep type may be present on the surface. The presence of a pancreatic "arrest" in the stomach wall is confusing, as the appearance may be very similar to that of other extramucosal tumors. Since pancreatic "arrests" do not bleed, the occurrence of bleeding would favor the diagnosis of other submucosal tumors.

In the past 27 years, 24 intramural tumors of the stomach have been removed surgically at the Massachusetts General Hospital; in 21 of these, fairly adequate roentgen examination was done. Sixteen patients gave a positive history of bleeding. Of the 21 cases examined roentgenologically, 20 showed a definite filling defect which was described as round, smooth, or lobulated; 9 showed ulceration. In one patient the tumor was not demonstrated roentgenologically. Two cases of ectopic pancreas were seen. Both of these showed a smooth rounded defect in the stomach, with a central dimple. This dimple represented the lumen of the duct for the aberrant pancreatic tissue and not an ulcer crater. The pathological diagnosis in the entire group of 20 cases was as follows: leiomyoma, 8; leiomyosarcoma, 6; neurofibrosarcoma, 4; neurofibroma, 2; sarcoma, 2; fibrosarcoma, 2; fibroma, 1.

L. W. PAUL, M.D.

**Bleeding in Hiatus Hernia.** O. D. Sahler and A. O. Hampton. *Am. J. Roentgenol.* 49: 433-441, April 1943.

Between 1930 and 1940, 221 cases of hiatus hernia were reported in the Department of Radiology of the Massachusetts General Hospital. This figure, however, does not represent the total number of patients with hiatus hernia, for in many cases the examiner did not regard such herniae of sufficient significance to record them. An analysis of the 221 recorded cases was made with special attention to the incidence of bleeding. Thirty-two patients had either moderately marked anemia or a positive history of gastro-intestinal tract bleeding; 19 of these gave a history of hematemesis, while 5 others had gastro-intestinal tract hemorrhage without hematemesis. In 10 of the 19 cases with hematemesis there was evidence of either gastritis or ulceration as determined by roentgenography, gastroscopy, or postmortem examination.

In order to determine the incidence of hiatus herniac, 100 consecutive clinic patients were examined during a two-month period. Each was examined in both the upright and horizontal position, with the esophagus filled with barium and in both the right and left oblique positions. Among this group, 9 cases of hernia were found, in 3 of which there was a history of having vomited small amounts of blood. It is the authors' opinion that many hiatus herniae will not be demonstrated if the supine and prone examinations are omitted. When a hernia is present, examination in the right anterior oblique position with the patient supine, and with the esophagus filled, will demonstrate the narrowing produced by the cardiac sphincter above the herniated fundus. The constriction of the fundus is evident as it passes through the diaphragm, as is the gastric mucosa. If the patient is turned to the left anterior oblique position, the esophagus is seen to enter at the right anterior margin of the herniated fundus. This asymmetry of the relation of the esophagus with the collection of barium above the diaphragm is of considerable importance in establishing the diagnosis. Care

must be taken not to confuse dilatation of the lower end of the esophagus during peristalsis with a hiatus hernia. If the facts mentioned above are kept in mind, no confusion will arise. In a rare case the actual hernial sac may be seen in the lower mediastinum as a soft tissue mass, fusiform in shape and smooth in outline.

Bleeding, when present, particularly hematemesis, may be due to the hernia, as a result of congestion of the blood vessels in the herniated portion of the stomach, with a resultant gastritis or ulceration.

L. W. PAUL, M.D.

**Primary Carcinoma of the Duodenum.** L. Berger and H. Koppelman. *Ann. Surg.* 116: 738-750, November 1942.

This paper is essentially a review and analysis of the literature dealing with all types of primary carcinoma of the duodenum. Each group is discussed from the standpoint of incidence, symptomatology, roentgenographic findings, pathologic picture, and recorded surgical results. In addition, the authors present a proved case of intrapapillary carcinoma of the duodenum.

Primary carcinoma of the duodenum is subdivided into suprapapillary, peripapillary, and intrapapillary types. The suprapapillary is that portion of the duodenum lying above the common duct opening and is derived from the foregut. The intrapapillary portion arises from midgut, while the papillary region is the zone between these two. Carcinoma in this last area may arise from the duodenum, ampulla of Vater, terminal bile duct, or terminal pancreatic duct; in the other areas it arises solely from the duodenal mucosa. In a review of the literature the authors found only 386 authentically proved cases of carcinoma of the duodenum reported up to the date of their paper. Of these, 65 per cent were peripapillary, 20 per cent suprapapillary, and 15 per cent intrapapillary. The over-all incidence is from 0.03 to 0.003 per cent of all autopsies, or in other words from one case in 3,000 to one in 30,000 autopsies. Hoffman and Pack estimate that duodenal carcinoma comprises 0.3 per cent of all intestinal carcinomas. Most cases occur in the sixth decade of life and males predominate.

Duodenal obstruction of varying degrees accounts for the chief symptoms in all malignant tumors of the duodenum. In the suprapapillary group the onset is acute in one-half of the cases, with vomiting, epigastric pain, weakness, weight loss, and later jaundice and dyspepsia. If the onset is more gradual, pain, dyspepsia, and weight loss are the most prominent symptoms. Of the 77 cases reported only 2 were correctly diagnosed preoperatively, and these from the roentgenograms.

In the peripapillary type the predominating symptom or sign is the early development of obstructive jaundice. This was acute in 80 per cent and was present in 99 per cent of the recorded cases. Pain, weight loss, anorexia, vomiting, constipation, and diarrhea were the accompanying symptoms in the order of frequency. A correct preoperative diagnosis was made in 20 per cent of the cases and roentgenographically suspected in 25 per cent.

In the intrapapillary group the principal symptoms are pain, vomiting, and cachexia, while constipation, diarrhea, anorexia, and jaundice are less common. In a series of 15 cases studied roentgenographically by Lieber, Stewart, and Lund, an obstructing lesion of the

duodenum was present in 40 per cent; in 27 per cent no lesion was demonstrated, while in 33 per cent the lesion was diagnosed as at, or near, the pylorus.

The authors' reported case was an infrapapillary carcinoma. The correct diagnosis was not made preoperatively and at operation, although a generalized carcinomatosis was revealed, no intrinsic lesion was discovered. At necropsy the primary site was found in the infrapapillary portion of the duodenum. Review of the roentgenograms showed a Y-shaped filling defect in the distal duodenum which had previously been overlooked. In the review of the literature the authors found similar diagnostic errors. These they believe are due partly to the vague and obscure symptoms often accompanying carcinoma of the duodenum, but chiefly to the fact that duodenal carcinoma, because of its rarity, is usually not consciously considered.

In conclusion the authors point out that, although the results of radical surgery so far have been discouraging (5.2 per cent five-year cures), with earlier diagnosis and with improved methods of preoperative and postoperative care, the future should show improvement.

P. C. BRIEDE, M.D.

**Primary Carcinoma of the Infra-Ampullary Portion of the Duodenum, with Example of Probable Origin from Aberrant Pancreatic Tissue.** G. L. Duff, H. L. Foster, and W. W. Bryan. *Arch. Surg.* 46: 494-503, April 1943.

Carcinoma of the duodenum is usually classified as supra-ampullary, peri-ampullary, and infra-ampullary. In any location it is rare, constituting only about 0.3 per cent of all intestinal cancers. Typically the patient complains of epigastric distress, usually aggravated by food and relieved by vomiting. There may also be a history of anorexia, weight loss, or alternating diarrhea and constipation. An epigastric mass and occult blood in the feces may be present. The period of illness before a physician is consulted is usually three to eighteen months; men are more commonly afflicted, and the age incidence lies in the fourth decade and thereafter. The condition has seldom been correctly diagnosed roentgenologically, but careful attention to the changes present should make the diagnosis possible.

A case of carcinoma of the infra-ampullary portion of the duodenum in a 35-year-old man is reported. The symptoms were classical. Roentgenologically there was an irregular tender narrowing of the duodenum just distal to the junction of the second and third portions, with a persistent fleck in the narrowed channel. At four hours 60 per cent of the barium meal remained in the stomach. After exploratory laparotomy, at which numerous metastases were found, the patient followed a downhill course and died. Autopsy showed that the tumor arose in aberrant pancreatic tissue.

Since the x-ray signs are typical, they should lead to a correct diagnosis in most instances. Sarcoma cannot be distinguished from carcinoma by x-ray examination.

LEWIS G. JACOBS, M.D.

**Enteric Intussusception in Adults.** W. H. Gerwig, Jr., and H. B. Stone. *Surg., Gynec. & Obst.* 76: 95-99, January 1943.

A rather unusual case of adult jejunal intussusception is presented. The patient had, in addition, a polyposis involving both the large and small intestines.

A 25-year-old male was admitted to the Station Hospital, Fort Meade, Maryland, Jan. 10, 1941, complaining of pain in the abdomen and across the lumbar region. Six years previously, he had suffered an attack of pain in the rectum, associated with bleeding, a constant desire to defecate, and a mass protruding from the anus. At that time a polyp with a long pedicle was removed. Four years later another polyp was removed. Twenty days before his admission to the Station Hospital at Fort Meade, the patient had a sudden attack of severe lower abdominal pain which gradually subsided but was followed by recurrent nausea. On Jan. 6 nausea, vomiting, abdominal cramps, and backache occurred and on the following day there was frequency of urination and the pain in the back became more severe.

Examination, on admission, showed tenderness over both kidneys. The abdomen was mildly distended, with no rigidity or local tenderness. Rectal examination was negative, as was a spot film of the abdomen. The original impression was perirenal abscess. On Jan. 11 the patient experienced extreme sharp pain in the abdomen and vomited dark brown fluid containing blood. Abdominal distention was increased and the pain now centered around the umbilicus rather than in the renal region. Peristalsis was audible. A diagnosis of acute intestinal obstruction was made.

On opening the abdomen, a hard mass was found lying in the pelvis. This proved to be a gangrenous, irreducible intussusception involving about 2 1/2 feet of the jejunum. A resection of the mass was carried out and an end-to-end anastomosis was performed. Hurried examination of the adjacent bowel revealed no palpable polyps.

Four weeks following the operation, while the patient was at stool, a small mass attached by a long narrow pedicle passed the anus. The pedicle was ligated and cut. After several weeks' convalescence a careful survey was begun. Repeated proctoscopic examinations were negative, and no information was obtained from two barium enemas. Eventually films made with the aid of a double contrast barium enema revealed several large polyps located in the region of the splenic flexure and sigmoid.

At operation one polyp, located 12 inches proximal to the original anastomosis, was removed. Five polyps were felt in the region of the splenic flexure and a resection of this area was carried out; it contained, in addition, numerous small polyps which were not palpable. Microscopic sections revealed a characteristic type of adenomatous polyp. One of these multiple lesions had probably caused the acute jejunal intussusception.

A general discussion of intussusception is included and special emphasis is placed on the necessity for location and removal of the organic etiological agent which is so frequently present in adults.

**Syndrome of Symptomatic Sprue in Lymphosarcomatosis of the Small Bowel and of the Mesenteric Lymph Nodes.** Robert Fritzsche. *Schwed. med. Wehnschr.* 73: 442-445, April 10, 1943.

Sprue is to be differentiated (according to Markoff: *Helvet. med. acta* (Supp. III) 5: 3-48, 1938) from steatorrhea, pernicious anemia with pancreatic damage, achylia pancreatica, acholic steatorrhea, mesenteric lymph node tuberculosis, intestinal tuberculosis, amy-

loid disease of the bowel, and gastrocolic fistula. These conditions lead to what may be called symptomatic sprue. A case of this type, due to lymphosarcomatosis, is reported.

A man 45 years old, accepted as healthy for military service in October 1939, began the following November to have abdominal pain and at times obstipation. In January 1940 a diagnosis of neoplasm was made. Examination revealed slight enlargement of the axillary and supraclavicular lymph nodes, but no other abnormality. There was a severe steatorrhea. Roentgenologic studies showed a dilatation of the small bowel with delay in the passage of the test meal, clumping of the barium, and loss of mucosal pattern. There was abnormally fast emptying of the colon. A diagnosis of severe jejunitis and colitis was made. Necropsy (April 1940) demonstrated an extensive lymphosarcomatosis (lymphoblastic type) of the jejunum, ileum, and mesenteric nodes.

LEWIS G. JACOBS, M.D.

### THE BILIARY TRACT

Diverticulum of the Gall Bladder: Review of the Literature and Report of a Case. M. Golob. *Am. J. Digest. Dis.* 10: 148-151, April 1943.

The author describes what he believes is a diverticulum of the gallbladder, basing this belief on two different cholecystograms, reproductions of which illustrate his article. No attempt was made to take a lateral view or an examination in the standing position. The diagnosis was not verified by operation.

JOSEPH T. DANZER, M.D.

### THE SPLEEN

Cysts of the Spleen. M. Paul. *Brit. J. Surg.* 30: 336-339, April 1943.

The *Echinococcus granulosus* is the only parasite giving rise to cysts in the spleen. Multiple cysts of the spleen are occasionally seen in cases of polycystic disease of the kidneys. Other splenic cysts fall into two main classes: large single cysts and multiple cysts. The large single cyst constitutes 80 per cent of the non-parasitic cysts. These cysts are of 3 types: (1) the dermoid cyst, which is very rare and probably due to epithelial cell inclusion; (2) cysts containing blood or altered blood, arising from intrasplenic hemorrhage; (3) epidermoid cysts, which do not contain sebaceous material or hair. These cysts contain a thin brown fluid, glistening from its content of cholesterol crystals. Outside the incomplete cellular lining of the cyst is a layer of firm laminated hyalinized fibrous tissue. The multiple serous cysts have an endothelial lining.

The symptoms produced by the large single cyst are due entirely to pressure on surrounding organs. X-ray examination after a barium meal will demonstrate a displacement of the esophagus and stomach to the right and a downward displacement of the splenic flexure. Splenectomy is the best treatment.

The author reports a case of a girl aged 19 with a mass in the left upper abdomen which grew progressively larger over a period of one year. Examination revealed a large fluctuating mass in the upper left abdomen extending from the costal margin to the level of the umbilicus. Roentgen examination after a barium meal showed the stomach lying vertically, to the right of the spine. At operation a large splenic cyst was found, occupying the whole left hypochondrium and epigas-

trium. The cyst contained a thin brown fluid, microscopic examination of which revealed red blood cells and cholesterol crystals. The cyst wall on section showed hyalinized fibrous tissue containing several cystic spaces lined by stratified epithelium. In view of a past history of malarial fever the origin of the cyst was attributed to an old intrasplenic hemorrhage. While the cyst in this instance was obviously of the solitary serous variety, the microscopic cystic spaces discovered in the wall suggest a transition stage to multiple serous cysts.

MAX CLIMAN, M.D.

### SUBPHRENIC ABSCESS

Left Subphrenic Abscess. H. Neuhoof and N. C. Schlossmann. *Surg., Gynec. & Obst.* 75: 751-758, December 1942.

This presentation is based on a study of 33 cases of left subphrenic abscess observed at Mount Sinai Hospital from 1928 to 1942; 51 cases of right subphrenic abscess were observed in the same period. The authors point out the decided differences in the anatomical, pathological, and clinical features of right and left subphrenic abscess and mention the disparity in mortality in their series: 35 per cent for right subphrenic abscess as compared with 75 per cent for left subphrenic abscess. The various organs bordering the left subphrenic space, and their mobility, render more complex the problem of diagnosis and treatment of left subphrenic abscess, as compared with the right.

All left subphrenic abscesses in the Mount Sinai series were secondary to intra-abdominal suppurative foci. Direct extension of infection from nearby organs was by far the most frequent mode of spread. The most frequent single source of infection was the stomach or duodenum (13 cases). Lymphatic dissemination played scarcely any role.

Clinical manifestations of left subphrenic abscess, usually vague and sparse, often appeared relatively late in the course of the disease. Indirect evidence of thoracic-abdominal manifestations was usually more significant than direct signs of a subphrenic abscess. An elevated, paralyzed diaphragm, a characteristic finding in right subphrenic abscess, was demonstrable in only 18 of 30 cases of left subphrenic abscess. The rise of the diaphragm in left subphrenic abscess may be masked, in the customary postero-anterior film, by supradiaphragmatic effusion. Lateral and oblique views may resolve difficulties in interpretation. Careful study of roentgenograms may offer the only basis for the correct diagnosis, as well as for a precise surgical approach to a left subphrenic abscess of the thoracic type. Varying degrees of pleural effusion so overshadowed the diaphragm in 7 instances that its position was completely masked in repeated roentgenograms. In some cases it may be necessary to ascertain the relationship between the stomach and diaphragm by the administration of medication producing gas in the stomach (Seidlitz powder, bicarbonate of soda). Exploratory aspiration is often imperative in order to establish the diagnosis.

In the operative treatment of left subphrenic abscess, a subpleural approach is advocated for abscesses of the "abdominal" type; a transpleural transdiaphragmatic approach for the "thoracic" type. A satisfactory one-stage transpleural transdiaphragmatic operation is described with a double sealing of the free pleura by two tiers of diaphragmatic sutures.

## THE SKELETAL SYSTEM

**Avascular Necrosis of Bone.** J. F. Brailsford. J. Bone & Joint Surg. 25: 249-260, April 1943.

An earlier study of 33 cases of Legg's disease followed by serial films led the author to recommend immobilization for a long period as the method of choice in the treatment of this condition. In 1932 he showed before the Medical Society of London (Trans. M. Soc. London 55: 251, 1932) roentgenograms demonstrating that for upward of four years the bone of the affected joint is plastic and easily deformed by pressure; if, however, the joint is immobilized during the plastic stage deformity does not occur. Further studies led in 1934 to a tabulation showing the various stages of the disease from its inception to complete healing. For the first two or three months, the bone is becoming plastic and there is (1) increased density of the femoral capital epiphysis; (2) relative increase in joint space; (3) osteoporosis of the diaphysis. In the next three to eighteen months, the bone is plastic and there are (4) compression and impression fractures of the epiphysis; (5) appearance of fragmentation; (6) compression and flattening of fragments; (7) gradual absorption of dense fragments; (8) compression and expansion of the proximal end of the diaphysis. In the next period—one and a half to four years—the bone is still plastic and the (9) first appearance of regeneration in the epiphysis is seen as absorption of the dense fragments; (10) appearance of circumscribed osteoporosis; (11) increased deposition of calcium and obliteration of the osteoporotic zone in the diaphysis. In and after the fourth year consolidation takes place and (12) the roentgenographic appearance becomes that of normal bone.

It has been held that Legg's disease is not an osteochondritis but simply an avascular necrosis; also that osteochondritis and avascular necrosis are one and the same condition. The author believes, however, that osteochondritis embraces "the more important concomitant living process," producing calcification and plasticity in the neighboring bone, permitting deformity when pressure is applied.

The roentgen changes are not identical with those following surgical trauma in the reduction of congenital dislocation of the femoral head, fractures of the femoral neck, or displacement of the femoral diaphysis from the capital epiphysis, though avascular necrosis may occur in these conditions. After vigorous attempts to reduce a congenital dislocation, there may be fragmentation of the femoral head, but here the fragmentation occurs in the regenerative phase and resembles ossification of the femoral head as seen in hypothyroidism. Also the process is more rapid than in Legg's disease and there may be severe damage to the growth cartilage, with consequent stunting of growth. Healing of a *slipped epiphysis* is associated with fusion of the epiphysis and diaphysis, which is not observed in Legg's disease. The mass necrosis of the femoral head and the pressure deformities of the femoral neck which occur in some cases present quite a different picture. *Fractures of the femoral neck* in children may show vascular changes. On the initial examination, there will be no difference in density of the fragments, but after a month or so some cases will show decalcification distal to the fracture while the proximal fragment appears increasingly dense, indicating interference with the blood supply here. Unless the fragments are immobilized at this time a coxa vara deformity will develop. If avascular ne-

erosis occurs, complete recovery may be delayed for several years.

Following a dislocation of the hip joint the femoral head may undergo avascular necrosis, due to interference with the blood supply in the production or reduction of the dislocation. It is unusual for fractures of the acetabulum to be followed by avascular necrosis of the femoral head.

Osteochondritis dissecans may occur in the femoral head. This the author believes to be due to injury of a localized segment of articular cartilage with permeation of synovial fluid which inhibits fusion. When the fragment becomes necrotic or displaced, symptoms develop.

The characteristic of necrotic bone is hypercalcification which is determined by comparison with the same portion of the opposite bone. Plasticity is another characteristic. However, not all areas of hypercalcification are due to avascular necrosis. The necrotic bone will gradually lose its density as it becomes infiltrated with living cells.

In cases of fracture of the femoral neck where the fragments have been pinned, necrosis may occur after two or three months. If weight-bearing is permitted, deformity and disability will occur. It is well, therefore, to keep the patient in bed for two or three months, when a roentgenogram will indicate whether the vascularity has been disturbed and whether or not union will occur.

JOHN B. MCANENY, M.D.

**Post-Traumatic Dystrophy of the Extremities: A Chronic Vasodilator Mechanism.** Géza de Takáts and D. S. Miller. Arch. Surg. 46: 469-479, April 1943.

Post-traumatic bone dystrophy, or Sudek's atrophy, is characterized in its early stage by severe, persistent, burning paroxysms of pain in a patient whose limb is properly immobilized, non-infected, and seemingly on the way to normal repair. In this stage the extremity is warm, the subcutaneous tissues and the periarticular spaces are edematous, and the muscles hypertonic. Pain is closely limited to the site of injury and there is no osteoporosis, which does not develop unless there has been hyperemia of four to eight weeks' duration. The syndrome may cease at this stage, or may progress to the second stage, in which the periarticular edema is more diffuse and the limb becomes hard, cyanotic, and cold. The joints become stiff rather early, and the pain resembles a spreading neuralgia. Finally, the skin becomes atrophic, the muscles atrophic, and osteoporosis appears, at first in a localized spotty fashion but later diffusely. There is nothing particularly characteristic about the osteoporosis, and it is doubtful if the diagnosis could be made from roentgenograms alone. The pain does not parallel the degree of osteoporosis.

Repeated plethysmographic studies, made in 12 of a series of 33 patients studied by the authors, showed an increased blood flow to the affected limb. Blood calcium and phosphorus levels were normal, but blood phosphatase was usually slightly increased.

Mild cases may subside spontaneously or yield promptly to paravertebral infiltration of procaine hydrochloride. In the more severe cases, though the course is self-limited and spontaneous healing normally occurs in a year, there are residual stiffness, deformity, and contractures. Functional and economic rehabilitation is hardly ever obtained. The condition seldom follows severe injuries and seems to be facilitated by

emotional factors. It is caused by a reflex vasodilation produced by sensory reflexes through the spinal cord.

If the syndrome is recognized in the first few weeks, repeated block of the local area and immobilization may abort the disease. Repeated paravertebral injections of procaine, each giving a longer period of relief, may be needed. If the relief is short-lived and symptoms recur promptly, periarthral sympathectomy should not be delayed. In some cases with severe intractable symptoms in association with compensation neurosis, drug addiction, or mental imbalance, no therapy is successful. Orthopedic correction may be needed in the presence of advanced atrophy after the pain has subsided.

LEWIS G. JACOBS, M.D.

**Familial Vertebral Dystrophy: Case Reports.** M. Halberstaedter. *Brit. J. Radiol.* 16: 121-124. April 1943.

Two brothers, 39 and 35 years of age, showed the same spinal defects. One sister and another brother were normal. Apart from the spinal defects there were no other abnormalities.

In both patients there were disproportionate shortness of the trunk, spinal rigidity, and dorsal scoliosis. The cervical spine was normal. The dorsal spine showed flattening and elongation of the vertebral bodies. In the case of the older there was some wedging, with secondary tipping of the anterior margins. There was a slight decrease in the intervertebral spaces. Some nuclei pulposi showed calcification. The upper and lower margins of the bodies were ill-defined and irregular, with notching just behind the anterior margin on the upper surface. The changes were less marked in the lumbar region. The pelvis in each case was slightly reduced in size.

The flattening and deformity of the vertebrae, the changes in the pelvis, and the absence of other bony defects classify this condition as Type C of Brailsford's chondro-osteo-dystrophy.

SYDNEY J. HAWLEY, M.D.

**Epiphyseal Dysplasia Punctata in a Mother and Identical Male Twins.** E. Resnik. *J. Bone & Joint Surg.* 25: 461-468, April 1943.

Because epiphyseal dysplasia has been considered to be due to thyroid hypofunction, the author presents the cases of a mother and her twin sons, who were followed from birth to puberty. In none of the three patients was there definite evidence of hypothyroidism, though the children showed a delay in bone age as compared to chronological age.

The mother had multiple osteochondritis diagnosed roentgenographically at the age of six. The early roentgenograms were not available, but more recent ones showed flattening of both femoral heads, foreshortening of the femoral necks, and upward displacement of the femoral shafts. Characteristic changes were present, also, in the humeral heads and in the bones of the hands.

The twins were delivered by cesarean section. At the age of ten one was found to have an aseptic necrosis of the capital epiphysis of the left femur. Under treatment (traction) complete regeneration took place. In the other twin pain and disability in the right hip occurred somewhat earlier. Roentgenograms showed flattening, fragmentation and increased density of the capital epiphysis. Response to treatment was less

satisfactory than in his brother. In both boys the humeral heads were stippled, the interphalangeal joints showed cupping and trumpeting, and there was evidence of irregular calcification in the epiphyses of the long bones.

JOHN B. MCANENY, M.D.

**A Prenatal Diagnosis of Osteopetrosis.** E. L. Jenkinson, W. H. Pfisterer, K. K. Latteier, and Mary Martin. *Am. J. Roentgenol.* 49: 455-462, April 1943.

An interesting case is reported in which a prenatal diagnosis of osteopetrosis was made. Films made in the sixth month of pregnancy revealed a small fetal skeleton with all of the bones unusually dense and widened. One week following the roentgen examination, the pregnancy was terminated and a macerated fetus delivered. Complete roentgenographic and pathologic study of the fetal skeleton was made, confirming the prenatal impression of osteopetrosis. The chief roentgenologic changes are listed as follows: increased density of practically all of the bones; widening of all of the long bones, especially the tibiae and ulnae; fine mottling of the long bones; narrowed medullary cavity; thickening of the cortex; no periosteal thickening; great density of the base of the skull; increased striae in parietal, frontal, and occipital bones; calcification of the kidneys; absence of periosteal thickening. The histopathological findings are described in detail.

In differential diagnosis congenital syphilis offers the greatest problem. Syphilis, however, unlike osteopetrosis, rarely attacks the bones of the base of the skull. Serological studies are very important in the differentiation from syphilis. Other lesions must also be considered. In leukemia the changes are predominantly destructive rather than proliferative, and when sclerosis does appear, it is less generalized. Chronic fluorine poisoning may present changes similar to those of osteopetrosis. Here the history is of great importance. The adjacent soft tissues may show osteophyte formation with calcification of the ligaments and with periosteal deposits. In older patients Paget's disease may present a problem, but the changes in the skull, pelvis, and long bones are usually quite characteristic, and the trabeculae, instead of being absent, are prominent and thickened. Chronic metallic poisoning such as lead or phosphorus poisoning, may be excluded by the history, chemical analysis, and examination of the red blood cells.

This case and others recorded in the literature are evidences that osteopetrosis undoubtedly originates *in utero* but it is not uncommon for patients suffering from this disorder to reach adult life.

L. W. PAUL, M.D.

**Sciatica and the Mechanism of the Production of the Clinical Syndrome in Protrusions of the Lumbar Intervertebral Discs.** J. E. A. O'Connell. *Brit. J. Surg.* 30: 315-327, April 1943.

The purpose of this comprehensive paper is to describe the typical syndrome of the lower lumbar intervertebral disk protrusions and the mechanism by which disk protrusions give rise to symptoms. The clinical observations were made on a series of more than 75 cases proved by operation, and only the disks between the 4th and 5th lumbar vertebrae and the 5th lumbar and sacrum are considered. The history is very important and the author stresses the distribu-



tion and type of pain, intermittency of symptoms, and paresthesiae. In more than half the cases there is a history of a definite injury which immediately, or within a short period, precipitated the pain. Examination of the spine reveals some deformity in a high proportion of cases. There may be a loss of the normal lumbar lordosis and a lateral tilt. Percussion in the lower lumbar and sacral areas may produce an exacerbation of the sciatic pain and at times paresthesiae in the areas in which they have previously been felt spontaneously. The importance of the straight leg-raising test—Lasègue's sign—is widely recognized. The author employs a modification of this test which consists of flexing both legs simultaneously. It will frequently be found that the angle of flexion permitted is greater than that allowed when the affected limb is flexed alone. After flexion of both straight legs to an angle just short of producing pain, lowering the sound limb will result in severe exacerbation of the sciatic pain. Flexion of the neck will produce the same result.

Radiographic examination is considered of little importance. Plain films of the lumbosacral region are made to exclude gross bone disease and to detect congenital variations. At times a narrowing of the affected disk may be demonstrated associated with lipping of the vertebral margins.

Lumbar puncture does not give much aid in the diagnosis of protrusion of a lumbar disk and was not performed in the later cases of this series.

The essential factor in the production of symptoms is believed to be the stretching of an intraspinal nerve in its extradural portion over or around the mass of protruded disk tissue. The *intradural* nerve roots in the lower regions of the spinal canal lie loosely and are not likely to be affected to the point of causing symptoms. The *extradural* portion of the spinal nerves is by comparison relatively fixed and immobile. Consequently slight pressure exerted against such an area may produce pain. Experimental work on cadavers revealed that the degree of tension in the intraspinal roots varied with the movements of the spine and limbs.

Several clinical signs of disk protrusions are considered in the light of the tension hypothesis. The obliteration of the lordosis is a mechanism which relieves tension in the sciatic nerve roots and thus diminishes discomfort. The same conditions apply to the scoliosis, which is usually toward the affected limb. The important straight leg-raising test is also explained on the basis of the tension hypothesis. The increase in tension which develops in the extradural roots as this movement is carried out will produce an exacerbation of the pain when the painful leg is tested.

MAX CLIMAN, M.D.

**Disseminated (Miliary) Tuberculosis of Bone With Multiple Localizations in the Skeleton: Report of Two Proved Cases.** John Lyford III. *J. Bone & Joint Surg.* 25: 453-460, April 1943.

The author gives two complete case histories of disseminated tuberculosis of bone, with foci in the bones of the trunk but no evidence of involvement of the hands or feet, distinguishing these cases from the osteitis tuberculosa multiplex cystica of Jüngling.

Both cases were chronic without lung or joint involvement. Trauma seemed to be the exciting cause in each. In one case the lesions were sclerotic without sinus formation. The other was caseous in nature, with multiple abscess and sinus formation.

In patients with multiple bone lesions, tuberculosis must always be considered in the differential diagnosis; its presence can be confirmed only by biopsy.

JOHN B. MCANENY, M.D.

**Bridging of the Vertebral Bodies in Tuberculosis of the Spine.** R. Perlman and J. A. Freiberg. *J. Bone & Joint Surg.* 25: 340-350, April 1943.

This is a report of 5 cases of proved tuberculosis of the spine in which bridging over the involved area occurred. All cases showed psoas abscesses. Bridging in the spine is usually considered to be due to pyogenic infection but none of these cases could be attributed to that cause. In four of the five cases bridging was considered adequate and surgical intervention was unnecessary. Much space is given to the discussion of whether tuberculosis of the spine occurs primarily in the disk, but the question remains unanswered.

JOHN B. MCANENY, M.D.

**Tuberculosis of the Ankle Joint: End-Result Study of Twenty-Five Cases.** S. S. Houkom. *Surg., Gynec. & Obst.* 76: 438-443, April 1943.

Surgical fusion is the treatment of choice for tuberculosis of the ankle joint at the New York Orthopaedic Hospital, and this is done as soon as the positive diagnosis is made and the patient is in physical shape for operation. This article presents a series of 25 consecutive cases treated by this method.

The age of onset varied from fourteen months to forty-five years, and the symptoms at the time of original examination were the usual ones of pain, swelling, fluctuation, heat, muscle spasm, limitation of motion, equinus deformity, sinuses, and a unilateral limp. Their duration was from six weeks to twenty-six years. Twenty-one of the patients had had previous treatment of various types. The diagnosis was made on the basis of the clinical, x-ray, and laboratory findings, and confirmed at operation.

When these ankles are fused, great care is taken to secure apposition of the raw bleeding bone surfaces. The foot is fixed in dorsiflexion of 100 to 110 degrees. In the group under consideration 16 patients required only one fusion operation, but 3 of these required additional fusion of the talocalcaneal joint for a stable foot. Four required two operations, 3 required three operations, and 2 patients required five operations each. The one possible unfavorable aspect of this method of treatment is the chance of dissemination of the infection to the talocalcaneal joint. It is possible that this occurred in 4 of these cases.

A walking cast is applied after about six weeks in a long leg cast, and if at the end of seven or eight months there is unsatisfactory evidence of fusion, refusion is usually carried out. The average period of disability in these patients was 1.2 years and ranged from three months to five years, as contrasted with 4.7 years with conservative methods of treatment. In 16 patients the result is classed as excellent, in 6 good, and in 3 fair. The gait following successful fusion is excellent.

The roentgenograms illustrating this paper are most satisfactory.

JOHN O. LAFFERTY, M.D.

**Congenital Dislocation of the Hip.** H. Platt. *Brit. J. Surg.* 30: 291-304, April 1943.

This paper, the Robert Jones Memorial Lecture delivered before The Royal College of Surgeons, opens

with a short biography and splendid tribute to the work of that great surgeon. The observations here recorded are based on the author's series of 349 cases covering a period of twenty-seven years.

The reduction of a congenital hip dislocation by manipulation followed by a period of fixation in plaster of Paris is still the method of choice. The author was able to re-examine 50 patients (62 hip joints) ten years or more after reduction; 46 of the 62 joints showed good or excellent function but a good or satisfactory anatomical result was obtained in only 29 instances. Among the causes of failure are anomalies of the joint capsule—such as attachment of the capsule to the femoral head, adherence of the capsule to the socket floor, or an abnormally developed limbus—which may prevent reposition of the femoral head into the depth of the socket; also skeletal anomalies, such as excessive anteversion of the femoral neck and failure of the acetabular roof to develop. The rare complication of osteochondritis is another unfavorable factor.

The indications for open operation are as follows:

(1) as a primary operation in certain dislocations in young children during the favorable age period, when there is evidence that the intrinsic obstacles to reduction are formidable; (2) in older children beyond the favorable age period, where closed reduction is obviously impractical or too dangerous; (3) in residual subluxation following closed reduction in older children. Good anatomical and functional results cannot, of course, be guaranteed in hip joints already damaged by repeated unsuccessful efforts to reduce the dislocation by manipulation. The operation requires considerable accuracy of technic and it is important to preserve the ligamentum teres with its potentially important arterial supply to the head of the femur. Weight-bearing is not permitted until there is radiographic evidence that no growth disturbance has been set up in the femoral head or socket.

In infants in the first year of life treatment consists in gradual abduction and involves the use of an apparatus known as a divaricator, on which the baby is fixed and from which it is removed at regular times for washing and nursing. Complete reduction is obtained after some weeks or even months. In Bologna, where this method originated, 94 per cent of a large series of cases thus treated showed excellent results. The author has used the method in only 13 cases. In 4 it was discontinued because of the inconvenience; in 1 it was a complete failure; in 8 the results were excellent. Two patients were still under treatment.

MAX CLIMAN, M.D.

**Tangential Osteochondral Fracture of the Patella.** J. E. Milgram. *J. Bone & Joint Surgery.* 25: 271–280, April 1943.

This presentation is made to bring attention to osteochondral fractures of the patella, that they may be recognized promptly, differentiated from the degenerative type of osteochondritis dissecans, and brought to early operation.

The usual story is that a child or young adult twists the knee; a loud noise, sudden pain, and possibly lateral dislocation of the patella occur. Hydrarthrosis and disability follow. Later a free body is found within the joint. If operation is performed early, it will be found that a piece of cartilage has been avulsed from the articular surface of the patella, usually in the medial inferior quadrant.

Four full case reports are presented, as are also roentgenograms and photographs of gross and microscopic specimens.

JOHN B. MCANENY, M.D.

**Case of Insufficiency Fracture Occurring in the Neck of the Femur.** R. L. Mansi. *Brit. J. Radiol.* 16: 119–120, April 1943.

So-called "insufficiency" or "fatigue" fracture is frequently found in service men, and may readily be overlooked, as there is no history of trauma.

The author's patient was a 19-year-old signalman, with no history of injury. His first complaint was slight pain in the right hip on walking. After five days this became so severe that he had to be excused from drill. He was treated for four days by rest and massage, but the pain persisted. On x-ray examination a fine fissure was observed on the inner side of the middle of the neck of the right femur. Six weeks later the fracture line had extended across the neck and was practically healed in good position. During the six weeks' interval the patient was up and about, doing office work. The pain gradually disappeared.

SYDNEY J. HAWLEY, M.D.

**Rare Internal Injuries of the Knee Joint.** E. Baumann. *Schweiz. med. Wchnschr.* 73: 435–437, April 10, 1943.

Injuries to the meniscus can as a rule be diagnosed with a high probability of correctness. Operative treatment can then be employed with success; but there are many surgeons who think that the joint should not be opened until a positive diagnosis has been made. Among the conditions leading to confusion are chondromalacia of the patella, a fairly common condition which can be proved at operation and treated by removal of the macerated focus. Osteochondrolysis dissecans of the femoral condyles is also a source of error; this can usually be diagnosed roentgenologically, and is best treated by rest, which leads to better results than operative excision of the focus. The unstable and stiff knee can be treated by plastic operation with bands of fascia lata. If an injury to the meniscus is diagnosed, excision is indicated. Some discussion of surgical technic is included.

LEWIS G. JACOBS, M.D.

**Two Rare Foot Injuries.** J. Heer. *Schweiz. med. Wchnschr.* 73: 449–451, April 10, 1943.

Two unusual cases are reported. The first is that of a 26-year-old man who was thrown off balance while carrying a 25-kg. weight on his shoulders. The strain was thrown on the front of the foot, which "cracked." Roentgenograms showed an upward and outward dislocation of the navicular on the talus with a fracture of the cuboid. Successful reduction was accomplished under ether anesthesia.

The second case was that of a 54-year-old factory worker whose foot was caught between an elevator and a wall. Roentgenograms showed fractures of the second metatarsal and the calcaneus (*sustentaculum tali*), but the most interesting part of the injury was a 90° rotatory dislocation of the cuboid. Reduction was accomplished by inserting a nail and turning the bone; a débridement and a plastic procedure were also necessary. Subcutaneous abscesses developed and considerable loss of function ensued.

LEWIS G. JACOBS, M.D.



**Metastatic Lesions of the Sternum.** H. B. Macey and G. S. Phalen. *Surg., Gynec. & Obst.* 76: 453-455, April 1943.

This article reports the 2 cases of metastatic carcinoma of the sternum which are among the 14 cases of neoplastic involvement of the sternum in the Mayo Clinic files.

In each of these cases the chief complaint was a constant dull pain over the sternum, occasionally extending to the interscapular region. There was no palpable or demonstrable mass about the sternum, but the roentgenograms in each instance showed a destructive lesion involving the sternal body. The biopsy in the first case showed carcinoma; in the second case the original biopsy diagnosis was an inflammatory lesion, but postmortem examination revealed carcinoma.

The primary site was not definitely located in the first instance, but from the nature of the tissue and arrangement of cells in the biopsy specimen it was thought to be the lung. In the second case there was a large lesion in the right upper lobe of the lung which was reported on roentgenographic examination to be active tuberculosis but was found on pathological examination to be adenocarcinoma. The pathologist was not certain that this was the primary growth, though no other site was demonstrated.

The authors make the point that every patient with sternal pain should have a roentgenographic examination, and that a biopsy should be taken if a destructive lesion is found. The roentgen illustrations do not show the lesions well.

JOHN O. LAFFERTY, M.D.

**Metastatic Malignancy of the Spine.** J. W. Toumey. *J. Bone & Joint Surg.* 25: 292-305, April 1943.

This is a review of the 95 cases of malignant metastases in the spine seen between 1936 and 1940 at the Lahey Clinic. These occurred in a total of 2,067 cases of malignant growth seen in that period. Carcinoma of the breast was the primary lesion in 42 cases, carcinoma of the prostate in 11 cases, and Hodgkin's lymphoblastoma in 7 cases. The site of origin was unknown in 15 cases, and the remainder are variously accounted for.

Pain due to spinal metastasis is often confused with arthritic pain. Traditionally, severe constant back pain unrelieved by recumbency or salicylates is characteristic of cancer. At times the first evidence of the presence of a malignant neoplasm in the body is obtained from a roentgenogram of the spine showing a metastatic deposit.

The various types of spinal metastases are discussed but no new information is presented. The conception of irradiation therapy in these lesions is not too well presented.

JOHN B. McANENY, M.D.

**Cystic Myxomatous Tumors About the Knee: Their Relation to Cysts of the Menisci.** R. K. Ghormley and M. B. Dockerty. *J. Bone & Joint Surg.* 25: 306-318, April 1943.

The authors present four cases of cystic myxomatous tumors about the knee joint, review additional cases from the records of the Mayo Clinic, and discuss the literature. A serious study both of the gross pathology and the microscopic pathology was undertaken in the cases recorded. Two were probably true cysts of the meniscus (one with an unusual amount of bone change); another was probably an unusually extensive develop-

ment of a parameniscal cyst, while the fourth was a true myxomatous tumor. The authors conclude that cysts of the meniscus are probably not actual neoplasms, but represent the end-results of a degenerative process. Such cysts may sometimes be distinguished from other cysts in the region of the knee joint by the absence of an endothelial lining.

JOHN B. McANENY, M.D.

**Solitary Benign Enchondroma of Bone.** H. L. Jaffe and L. Lichtenstein. *Arch. Surg.* 46: 480-493, April 1943.

Solitary benign enchondroma is a cartilaginous tumor involving a single bone. The lesion appears most often in the phalanges, metacarpals, humerus, and femur, although other sites may occasionally be involved. It arises in the interior of the bone and may or may not cause distention of the cortex. Slow malignant transformation to chondrosarcoma is by no means rare.

The authors' series includes 28 cases, of which 12 were in males; the age range was from eleven to fifty years. Fourteen of the tumors were in phalanges, 5 in the metacarpals, 5 in the humerus, 3 in the femur, and 1 in a metatarsal. The clinical history is variable. There may be no symptoms until local trauma leads to pathological fracture, or the patient may give a history of a painless or slightly painful spontaneous swelling dating back several years. Repeated episodes of injury and recovery may be observed. A local bony swelling can usually be palpated.

In the phalanges the roentgenogram shows a centrally situated or eccentric oval area of rarefaction with or without bulging of the cortex. Small dense areas of ossification may be scattered through the rarefied area, which has a cloudy, vaguely trabeculated appearance. The lesion does not extend across an epiphyseal line. These phalangeal enchondromas are often misdiagnosed as cyst, giant-cell tumor, or osteochondroma; but a solitary tumor involving a phalanx is almost certainly an enchondroma.

Enchondromas of the metacarpals and metatarsals resemble roentgenologically those of the phalanges; they tend to appear in the distal part of the shaft. In these bones an area of fibrous dysplasia or an ossifying fibroma may closely mimic an enchondroma. In other long bones a similar situation obtains; the presence of small scattered areas of ossification in the radiolucent zone speaks strongly for enchondroma, but their absence leaves the situation uncertain.

Pathological studies of these tumors are rare, as they are seldom removed whole. In general, fragments of cortical bone from areas where there has been bulging of the cortex, as is commonly the case in the phalanges, metacarpals, and metatarsals, are thin and even shell-like. Fragments from lesions that do not cause bulging, as in the long tubular bones, show little thinning. In either case there are some erosive ridging and grooving of the medullary surface. The tumor tissue is a bluish-white, firm or somewhat myxomatous hyaline cartilage, containing some areas of calcification or ossification. There is a decided tendency to lobulation. In a true benign enchondroma the cells are small, with pale vacuolated cytoplasm and a small, single, rounded nucleus. Only occasional binucleated cells are present. If numbers of binucleated cells are present, if there is a general "plumping up" of the nuclei, and especially if there are numbers of large cells with large multiple

nuclei, the tumor is no longer benign and should be considered a chondrosarcoma.

The treatment of choice is conservative surgery: curettement, perhaps followed by chemical cauterization and implantation of bone chips or insertion of a solid graft. In one case 10 x-ray treatments (not given by the authors, and details unknown) failed to help the patient, and after operation infection developed in the bone. In 23 of the authors' 28 cases, results are known to have been good, without recurrence; fair results were obtained in 4 others, without recurrence, although various deficiencies were present, in some instances due to over-radical surgery. One patient had malignant degeneration of an enchondroma of the humerus; resection of the upper end of the bone was undertaken and there had been no recurrence after four and a half years.

LEWIS G. JACOBS, M.D.

**Lesions of the Supraspinatus Tendon: Degeneration, Rupture, and Calcification.** C. L. Wilson. *Arch. Surg.* 46: 307-325, March 1943.

The subacromial bursa lies beneath the deltoid muscle, the coraco-acromial ligament, and the acromion, intervening between these structures and the supraspinatus tendon. Its floor is formed by the blended fibers of the four short rotators (the supraspinatus, infraspinatus, teres minor, and subscapularis), the so-called "musculotendinous cuff." The attachment of the tendons is on the upper half of the sulcus, which constitutes the anatomical neck of the humerus, and on the greater tuberosity. The function of the rotator muscles, which tend to act as a unit, is to hold the head of the humerus in the glenoid in abduction. The long head of the biceps also acts as a stabilizer.

Rupture of the supraspinatus tendon was first recognized by J. S. Smith in 1835 (*Am. J. M. Sc.* 16: 219, 1835). It occurs as a transverse tear within half an inch of the insertion on the greater tubercle. Incomplete rupture may take place on the joint side (a "rim rent"), in the floor of the subacromial bursa, or within the substance of the tendon. Generally communication is established between the subacromial bursa and the joint space. In some cases all four tendons may be avulsed. After rupture of long standing the tab of tendon on the humerus disappears and small bony excrescences form; the walls of the bursa, normally film-like, become thick as blotting paper, and synovial villi are found in the bursa. The tendon of the long head of the biceps, exposed by the tear in the supraspinatus tendon, may fray or rupture.

Rupture of the supraspinatus tendon was found in 20 per cent of an autopsy series and in 26.5 per cent of a series of anatomic cadavers. Its cause is not certainly known, but it is thought to be due to degenerative changes in the tendon in late middle and advanced age. Laborers are more prone to this accident than sedentary workers.

The clinical picture starts with an acute trauma, usually a fall with sudden elevation of the arm. Immediately sharp, brief pain is felt at the tendon insertion, but the pain is seldom severe enough to cause the patient to stop work. Later in the day the pain becomes worse and even intolerable. There is inability to raise the arm, but little limitation of motion when the patient leans forward at the hips with the arms hanging. A tender point and sometimes a ridge can be felt anterior to the acromion tip with the arm in dorsal flexion; these disappear as the arm is passively

elevated. If the findings are doubtful and the patient can hold the arm in right-angle abduction, complete rupture is not present. The initial pain is severe, but it later becomes nagging and continues unchanged for months; it is aggravated by work. After two to five years the pain may disappear spontaneously. The initial symptoms of rupture of the long head of the biceps are variable.

Two roentgenographic methods have been employed in diagnosing rupture of the supraspinatus tendon. Henry (*Am. J. Roentgenol.* 33: 486, 1935) uses a soft-tissue technic with the arm adducted and internally rotated; immediately after injury fine spicules of bone can be shown on or near the greater tuberosity; but if rupture occurs in the critical part of the tendon the findings may be normal. Lindblom (*Acta radiol.* 20: 548, 1939) injects 6 c.c. of 35 per cent diodrast mixed with 1 c.c. of 1 per cent procaine hydrochloride into the shoulder joint. In the intact joint the roentgenogram shows only the joint space, but if rupture has occurred the subacromial bursa is also filled. In early cases treatment by surgical repair is successful.

Calcification of the supraspinatus tendon was first recognized in roentgenograms by Painter in 1905 (*Boston M. & S. J.* 156: 345, 1907). Pathologically there is a boil-like elevation on the floor of the subacromial bursa, containing a soft creamy calcium deposit. This may rupture into the bursa, producing a chemical bursitis. In the chronic phase there is little to be seen in the bursa, and the deposit becomes cheesy or gritty. The calcium is deposited either as the phosphate or oxalate. Such calcifications were found (with a fluoroscopic technic) in 2.7 per cent of 6,061 supposedly normal persons by Bosworth (*J. A. M. A.* 116: 2477, 1941). Long continued use of the arm in abduction seems to be a predisposing factor. A single trauma does not cause calcification, but may precipitate symptoms. Infection plays no part in the condition.

Symptoms may be absent, or chronic or acute pain may be present. Acute attacks are excruciating and the pain is aggravated by any movement of the arm. Voluntary fixation may even lead to contracture. Spot roentgenography after fluoroscopic localization will demonstrate the calcification. In the acute stage, prompt excision is advocated. In the chronic stage treatment is difficult to evaluate because recovery takes place regardless of the measures employed. Operation is nevertheless advocated for these patients also.

Subacromial bursitis is always a secondary condition. Calcification and rupture of the supraspinatus tendon may lead to a bursitis; tuberculosis of the bursa is rare. The so-called "frozen shoulder" may be treated by forced abduction, although the bursa shows little change on examination.

A comprehensive bibliography accompanies this paper.

LEWIS G. JACOBS, M.D.

## THE SPINAL CANAL

**Two-Needle Oxygen Myelography: A New Technique for Visualization of the Spinal Subarachnoid Space.** D. Munro and C. W. Elkins. *Surg., Gynec. & Obst.* 75: 729-736, December 1942.

The authors discuss the advantages and disadvantages of lipiodol, thorium dioxide, air, and oxygen as media for the visualization of the spinal arachnoid space. Both air

and oxygen are satisfactory contrast media, provided the canal is filled, and have the advantage that they are readily absorbable and do not serve as permanent irritants. In many cases, however, x-ray films made according to the Chamberlain and Young technic, with the alternate injection of air and withdrawal of spinal fluid, are worthless from a diagnostic standpoint because of poor or inadequate filling. This is believed to be unavoidable because of the fallacious hydrodynamics inherent in the technic.

The authors came to the conclusion that the use of oxygen had the fewest disadvantages and therefore modified Chamberlain and Young's method in such a way as to make it hydrodynamically correct and, instead of one, used two spinal needles. By placing one needle in the low lumbar region and varying the position of the other, they are able to fill the spinal canal accurately and satisfactorily not only in the lumbar region, but in the thoracic and cervical regions as well.

The technic of two-needle myelography is as follows: After preparation, consisting of one ounce of castor oil by mouth and a soapsuds enema on the night previous to the examination, the patient is placed in the lateral position on a tilt-top x-ray table with a Bucky-Potter diaphragm. An adjustable webbing sling keeps the patient in place when the table is tilted. A low lumbar puncture is performed, followed by another puncture at the desired cephalad level of fill. If the entire canal is to be visualized, the cephalad needle is placed in the cisterna magna. If the thoracic and lumbar region is to be visualized, the cephalad needle is placed at the desired level in the thoracic region. If done with care and proper technic, the thoracic spinal puncture may be performed with impunity. If the lumbar area alone is to be visualized, the cephalad needle is placed between the twelfth thoracic and the first lumbar vertebra. Number 18 gauge Fremont-Smith needles with three-way stopcocks are used for the punctures. Simultaneous pressure readings, water manometers being used, are taken from the needles. The Queckenstedt block test is done by means of a blood pressure cuff around the patient's neck to compress the jugular veins. The cuff pressure is increased by increments of 10 mm. of mercury until a pressure of 40 mm. is recorded in the cuff. The spinal fluid pressure is determined and recorded after each increment. The cuff pressure is then lowered by increments of 10 mm. of mercury until the pressure is zero in the cuff. The spinal fluid pressure after each increment is determined and recorded. By this method, differential intraspinal pressures are obtained and, if a block exists between the two needles, it may be demonstrated. Partial block may also be demonstrated by this method.

Two cubic centimeters of spinal fluid are now removed from each needle. This is for protein determinations and cell counts. Differential protein values are thus obtained simultaneously from below and above the suspected lesion.

After the fluids are collected, the patient's head is lowered to 25 degrees below horizontal and both needles are opened. Fluid will flow from the cephalad needle and, as this occurs, oxygen is slowly injected into the caudal needle. The injection is made from a sterile 50-c.c. syringe which has been filled from a small oxygen tank. Care must be taken not to inject the oxygen under pressure, as this expands the canal and may possibly distort it. When spinal fluid ceases to flow from the cephalad needle and oxygen appears, both needles

are closed. Stereoscopic lateral roentgenograms are then taken of the lumbar and thoracic levels. Oblique views are used and satisfactorily replace both the lateral and anteroposterior views in the cervical level. This is done so that the tracheal shadow will not be superimposed upon the injected column of air. As little delay as possible should occur between the completion of injection and exposure of the x-ray films, since the gas tends to absorb quite rapidly in some cases. To avoid this complication, the needles are left in place while the lateral views are taken. After these are completed, both needles are again opened and more oxygen is injected. The needles are then withdrawn, the patient is quickly turned on his back, and stereoscopic anteroposterior and oblique films are taken. Twenty to thirty cubic centimeters of oxygen are usually sufficient to fill the lumbar area, 40 to 50 the midthoracic and lumbar areas, and 75 to 100 the entire spinal canal.

Sixty-nine myelograms have been done by the two-needle method on 60 patients. With the assistance of the myelograms, the decision was reached that 37 of the 60 patients studied did not need surgical interference. In 31 patients in this group, the findings were considered normal. In 9 patients a diagnosis of protrusion of the nucleus pulposus following rupture of an intervertebral disk was made on the evidence of the myelogram and other data. At operation the protruded nucleus was found exactly as demonstrated by the myelogram in every instance. Seven patients were explored for a suspected ruptured intervertebral disk in spite of negative two-needle myelograms, but none was found. The operative findings disagreed with the myelogram in only 2 of the 23 patients that were operated upon.

Myelograms were repeated in 5 instances because the first ones were not satisfactory. Satisfactory visualization of the subarachnoid space was eventually obtained in every case.

**Roentgenologic Diagnosis of Dilatations of the Spinal Cord Veins: Report of a Case.** B. S. Epstein and L. M. Davidoff. *Am. J. Roentgenol.* 49: 476-479, April 1943.

Intraspinal vascular dilatations may occur as true dilatations of the spinal veins, as arterial or arteriovenous aneurysms, or as hemangiomas. The last form a separate group and are neoplastic. Non-neoplastic venous dilatations may be due to some interference in the spinal venous circulation or to congenital anomalies in the development of the veins. Diagnosis may be possible on roentgen examination with iodized oil as a contrast medium. A case is reported in which a correct preoperative diagnosis was possible by this method. The varices produce a pattern of negative serpentine shadows, since the dilated veins lie in the spinal canal and are surrounded by the cerebrospinal fluid. Roentgenoscopic inspection revealed a free flow of the oil throughout the canal, but the film showed the presence of numerous negative shadows with smooth, parallel sides in the lower cervical region and a similar defect in the lower dorsal area. Laminectomy revealed a thick vermiform varix on the dorsal aspect of the cord, extending beyond the limits of the operative field. A constant roentgenographic picture need not be present, since the veins may on occasion be dilated and at other times collapsed.

Roentgenograms are reproduced, illustrating the case reported. L. W. PAUL, M.D.

## THE GENITO-URINARY TRACT

**Technical Considerations in Excretory Urography.** R. O. Pearman. *New England J. Med.* 228: 507-508, April 22, 1943.

In an attempt to determine the best preparation for excretory urography 200 cases were studied and the following observations were made. Good technical films are essential. If the blood urea is above 70 mg. per 100 c.c. it is unlikely that good excretion will occur. Abdominal compression is not of value, but a 5- to 10-degree Trendelenburg position may afford better filling of the pelves.

Films are taken at five, twenty, and forty-five minutes after injection. In patients with hypertension the first film should be exposed at three minutes because of the rapidity of excretion in these cases. If satisfactory visualization is obtained at five minutes, renal function may be considered to be good, but the reverse of this is not always true.

The best preparation of the bowels seems to be limitation of fluid intake to 250 c.c. for 8 hours, omission of meals, and castor oil with or without an enema about fourteen hours before roentgenography.

JOHN B. McANENY, M.D.

**Pyelograms in Patients with Essential and Malignant Hypertension.** J. C. Shrader, J. M. Young, and I. H. Page. *Am. J. M. Sc.* 205: 505-514, April 1943.

This study was undertaken to determine whether or not there is a pyelogram characteristic of hypertension and to compare the incidence of abnormal pyelograms in an unselected group of patients with hypertension with that in an unselected group of "normotensive" controls.

Retrograde pyelograms were studied with regard to morphology, such as level in relation to the vertebrae, renal rotation, capacity of the pelvis, calyceal size in relation to pelvic size, and tendency to bifid pelvis.

Twenty-two per cent of a group of easily recognizable renal abnormalities occurred in patients with hypertension, a figure in general agreement with those of other investigators. Nineteen per cent of a series of hypertensive patients showed abnormal pyelograms. The average mean arterial pressure, however, was the same in subjects with normal and abnormal pyelograms.

The authors conclude that the retrograde pyelograms of patients with essential hypertension do not differ significantly from those of "normotensive" subjects, and that the incidence of urographic abnormalities in an unselected group of "hypertensives" appeared to be no greater than in "normotensives." It was their impression that the range of normal variation in urograms is wider than is usually recognized. Questionable pyelographic variations in patients without hypertension are often disregarded, while the same variations in the hypertensive patient are emphasized, and he becomes a so-called "renal hypertensive."

BENJAMIN COLEMAN, M.D.

**Aneurysm of the Renal Artery.** O. S. Lowsley and E. M. Cannon. *J. A. M. A.* 121: 1137-1143, April 3, 1943.

In this article is described the seventy-fifth case of aneurysm of the renal artery that has been reported and the twelfth that has been diagnosed preoperatively. True aneurysm in this location is probably due to a

congenital defect in the arterial wall, and, when small, generally presents no clinical symptoms. When it enlarges, the most constant symptom is flank pain. Rupture of the aneurysm produces a false aneurysm or retroperitoneal hematoma, which may be palpated as a mass in the flank or upper abdomen. A systolic bruit or pulsation is pathognomonic but only rarely encountered. Hematuria is uncommon.

The significant roentgenographic sign is a ring-like shadow of calcification with a dense periphery disrupted in one portion, located in the kidney or hilar region. This sign, of course, is not always present and must be differentiated from a host of other shadows which may occur in this same area.

The prognosis in symptom-producing aneurysms of the renal artery is grave unless nephrectomy is performed. An exploratory operation is justified when the abnormality is suspected, even though signs and symptoms are lacking.

Various discussants of this paper emphasized the potentialities of arteriography and less radical vascular surgery, in the diagnosis and treatment of this rare condition.

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## VENOGRAPHY

**Method for Obtaining Venograms of the Veins of the Extremities.** H. Mahorner. *Surg., Gynec. & Obst.* 76: 41-42, January 1943.

The author's technique for visualization of the veins of the extremities is as follows. With the patient sitting on the x-ray table with legs dependent, a 20-gauge needle is inserted into a vein on the dorsum of the foot or on the ankle, one of the tributaries of the internal saphenous system. (The course of the internal saphenous is anterior to the internal malleolus and relatively superficial, usually permitting insertion of needle without an incision.) The tubing of an infusion set containing normal salt solution is connected with the needle and the infusion is permitted to drip relatively rapidly. The needle is then strapped securely in position with adhesive and the patient lies down on the table. A large cassette containing the films is placed behind the calf and thigh and the leg is slightly rotated externally. A tourniquet is applied around the leg, usually at the junction of the middle and lower thirds, sufficiently tight to impede circulation in the superficial veins, which shunts the infusion from the superficial into the deep system. Twenty cubic centimeters of diodrast (35 per cent) are then slowly injected into the tubing of the infusion set just above the needle. Five seconds after the diodrast is completely delivered, an exposure is made. After the exposure the infusion continues to run for 200 c.c. to wash the diodrast from the veins. It is then possible to rotate the leg and get a lateral or oblique view or, if desired, a new plate may be placed higher under the thigh and the femoral veins exposed. Venograms made with this technique are reproduced. A word of caution as to possible complications is added.

## FOREIGN BODIES

**Simple Foreign Body Removal.** S. D. Mesirov and R. A. Arens. *Illinois M. J.* 83: 179-182, March 1943.

A simple method of removing a foreign body by combined fluoroscopy and surgical exploration, based

on the principles of the "nearest point method" given in the U. S. Army X-Ray Manual, 2nd edition, is presented. This method involves the use of a small hand screen which can be placed in the field of operation without producing contamination, as described by Arens (*Am. J. Roentgenol.* 14: 460, 1925).

The authors bring out the point that, since there may be and usually is movement of the foreign body or of the tissues containing it, either before or during exploration, intermittent fluoroscopy offers a constant control by indicating continuously the position of the foreign body. This method of removal is not suitable for foreign bodies deep in the lung fields, within the abdominal cavity, or those requiring exploration of vital structures.

With regard to the possibility of radiation injury, the authors state that in the usual case there is an average of five to ten minutes' actual working time from incision or probing into the wound of entry until removal of the foreign body, involving at most one to two minutes of actual fluoroscopic time. "Using 85 PEv., 4 ma., 1 mm. Al, one obtains radiation equivalent approximating 5 r per minute, a relatively insignificant amount. A small cone of radiation is used sufficient only to fill the screen of the roentgenoscope." Continual use of one roentgenologist-surgeon team might, however, constitute a hazard due to the possible effects of cumulative radiation.

### READING OF ROENTGENOGRAMS

The Reading of Roentgenograms (In commemoration of Dr. R. Lindt, of Aarau, 1868-1940). W. Jaeger. *Schweiz. med. Wchnschr.* 72: 1429-1431, Dec. 26, 1942.

Although the roentgenogram is in itself unchangeable, there is no absolutely pathognomonic picture of a disease. Changes in the shadows may be of such magnitude as to imply certain pathological processes, but the picture may be influenced by technic and positioning as well as by the physical peculiarities of the patient. Stereoscopy may be helpful, but is of limited scope, since about half of all persons have no faculty for stereoscopic vision and some of the others misinterpret the location of what they see. We must not forget, therefore, that we are merely interpreting shadows. (The best proof of the difficulty of this is to try to identify, out of a series of shadow profiles, that of one's own wife!) For this reason it behooves us to correlate our pictorial findings with the history and clinical findings in reaching a diagnosis.

Physical qualities such as thickness and density and superimposition of shadows may alter a picture materially. This means that the positioning of the patient must be precise and the technical factors accurate. Individual anatomical variations, especially in the skeleton, must not be misinterpreted; they are numerous and a frequent source of error. Studies of the soft tissues with contrast media must be interpreted with caution, three questions being borne in mind: (1) Is the filling complete? (2) Is the contrast medium spilled on the body surface, or are the ramifications observed internal? (3) Does the body react to this medium in any abnormal fashion?

Finally, one must study the entire roentgenogram for changes, remembering that parts other than those principally under consideration may be the seat of disease or abnormality. LEWIS G. JACOBS, M.D.

Diagnostic Judgment in Traumatic Medicine and the Roentgenogram. F. Lang. *Schweiz. med. Wchnschr.* 73: 497-500, April 24, 1943.

Roentgenograms are objective documents which preserve conclusive evidence of pathological states for the future. This diagnostic aid is frequently indicated in traumatic medicine. Its use depends on two factors, namely, the technical skill with which the picture is made and the knowledge and skill of the interpreter. Roentgenograms must be made as often as indicated, since it is false economy to miss minimal lesions which, when untreated, may lead to high grades of invalidism or disability. For the same reason, an adequate number of films must be made.

Roentgenograms should be made more often in cases in which a bone lesion is suspected; after accidents which frequently lead to fracture, even in the absence of clinical evidence of fracture; of adjacent parts after injuries with positive findings in one area; in the presence of persistent, obscure pain; always if compensation is an issue. Films should be made in two planes and should be large enough to cover the entire area involved; interval studies are usually advisable.

A number of illustrative cases are briefly cited. Particularly striking are illustrations of a fracture of both bones of the forearm, missed on the original study because too small an area was included in the film, and of a spondylolisthesis undiagnosed because the top only of the fifth lumbar vertebra was included in the original study.

Although this article contains nothing not already well known, the general practitioner and industrial surgeon will find it profitable reading.

LEWIS G. JACOBS, M.D.

Medical Facts That Can or Cannot Be Proved by Roentgen-Ray: Historical Review and Present Possibilities. S. W. Donaldson. *Ann. Int. Med.* 18: 535-550, April 1943.

The author cites various instances in which the courts have recognized the necessity not only of accurate portrayal of parts on the roentgenogram but also of expert interpretation of the findings.

The fundamental concept for roentgen ray examination is that a roentgenogram "is merely a photographic record of the different densities through which the x-ray has passed." The obvious conclusion is that a diagnosis cannot be made if a difference in density cannot be demonstrated.

The author lists, by systems, the diseases in which roentgenography can and cannot be considered diagnostic. Recognizable radiologic conditions, such as fractures, calculi, bone lesions, etc., will be omitted from further discussion here. A brief review of non-recognizable conditions follows:

*Eye:* Non-opaque foreign bodies in the eye, as well as soft tissue lesions of the eyeball and orbit, are not demonstrable in the absence of secondary bone changes.

*Chest:* The effects of noxious gases upon the mucous membranes of the tracheobronchial tree are negative roentgenologically. Similarly, spray painters using cellulose products fail to show any lung changes in the roentgenogram.

*Abdomen:* Acute appendicitis, acute pancreatitis, and pelvic inflammatory disease rarely show diagnostic differences in density on routine examination. This is also true of diseases of the spleen which do not produce enlargement or cause calcification. In rupture or per-

formation of the liver or spleen, the x-ray findings may be apparent, but not sufficiently convincing for a positive diagnosis.

**Circulatory System:** Peripheral vascular diseases, varicose veins, and thrombophlebitis usually present no positive roentgen-ray findings, except on special examination with contrast media. Neurotrophic conditions resulting in atrophy of the bones of the hands and feet, as Raynaud's or Buerger's disease, show changes of the bone, but never of the vessels, even with the soft-tissue technic.

**Bones and Joints:** A positive decision that herniation of an intervertebral disk extends into the spinal canal cannot be made without the aid of a contrast medium, either air or iodized oil. Acute conditions, as acute osteomyelitis and joint tuberculosis are not readily recognizable. Small areas of metastatic cancer are not always visible even though they may be suspected clinically. Myositis ossificans (calcium deposit in the muscle) is a frequent post-traumatic finding in cases in which the films at the time of injury were negative. In the great majority of acute sacro-iliac cases, the x-ray findings are negative. In hypertrophic osteo-arthritis, lipping, spurs, or marginal deposits are

brought about by chronologic or anatomic age, and are physiological in nature. Obviously, aggravation of these changes is impossible, as they represent normal healthy bone.

**Genito-Urinary System:** Such unusual conditions as carbuncle of the kidney and hemorrhagic nephritis, and their complications, cannot be readily diagnosed. Dysmenorrhea and acute venereal infections are not within the province of the radiologist.

**Cerebro-Nervous System:** Most of the diffuse organic neurological conditions, such as multiple sclerosis, amyotrophic lateral sclerosis, and nerve injuries, especially those of the brachial plexus at birth, are not amenable to x-ray diagnosis. Meningitis and encephalitis offer little information roentgenographically.

The author concludes with suggestions for further research. It is possible that the pancreas might be visualized by developing a chemical substance which would be selectively secreted with the pancreatic juice. The electron microscope may eventually perfect the fluoroscopic screen so that objects of fine structure will be seen with ease. The radioactive substances produced by the cyclotron present further possibilities.

STEPHEN N. TAGER, M.D.

## RADIOTHERAPY

### NEOPLASMS

**Cancer of the Nasopharynx.** C. L. Martin. *Ann. Otol., Rhin. & Laryng.* 52: 146-160, March 1943.

Because surgery has accomplished relatively little in the treatment of cancer of the nasopharynx, many otolaryngologists have adopted a gloomy attitude toward the treatment of this condition. Since the divided dose method of administering x-ray therapy advocated by Coutard came into use about ten years ago, the picture has changed, however, and an encouraging number of cures have been reported. In 1940, Martin and Blady (*Arch. Otolaryngol.* 32: 692, 1940) reported 25 per cent of five-year cures in a series of 80 patients, and in 1942 Lenz (*Am. J. Roentgenol.* 48: 816, 1942) 27.6 per cent of 44 patients. All of these cases were treated by irradiation alone and each series includes all of the patients treated regardless of the stage of the disease.

Those promising results are based on the fact that approximately 85 per cent of the primary lesions are so radiosensitive that they can be completely eradicated by doses of irradiation which produce no irreparable damage to normal tissues. While such therapy sets up painful reactions in the mucous membranes and the skin of the treated areas, these reactions heal in two or three weeks and are relatively insignificant when compared with the results obtained.

From a review of his own cases conducted in 1939, the author observed that many of the failures resulted from the appearance of metastases in the mediastinum or intracranial cavity four to six months after the disappearance of all evidence of the disease in the pharynx and the cervical region and came to the conclusion that more cures might be obtained by administering additional irradiation to the base of the skull and thorax in the early cases. He describes the technic as follows:

"1. Areas laid out over each side of the pharynx should extend from the lateral wall of the orbit to a point one-half inch behind the mastoid and should include the base of the skull and the submental area as well as the upper portions of the triangles of the neck. The total dosage given to each area during a period of three and a half weeks averages 3,200 roentgens measured in air and should rarely exceed this amount.

"2. When the reaction from this series has subsided, a third area of similar size laid out over the base of the occipital region and the back of the neck should receive 3,000 roentgens at the rate of 300 roentgens per day.

"3. At, or about, the same time 2,400 roentgens should be delivered through 15-cm. portals to the front and back of the upper mediastinum at the rate of 300 roentgens per day in an effort to forestall downward extension through the lymphatics in this region."

The author states that, although no five-year statistics are yet available, the results observed in a small group of patients have been encouraging.

**Intra-oral Radium Treatment of Cancer of the Mouth.** Part I. Choice of Method. Part II. Technique. J. R. Nuttall. *Brit. J. Radiol.* 16: 45-48, February, 1943; 72-81, March 1943.

This article represents in summary the experience in treatment of 1,300 patients between 1932 and 1938 in the Manchester Radium Institute.

As squamous-cell carcinoma is relatively resistant, there is only a small margin between the dose lethal to the tumor and the dose which will produce necrosis in normal tissue. The optimum dose is between 6,000 and 8,000 r delivered in seven to ten days. The first onslaught should be the largest possible, for normal tissues will probably not stand a second.

At the outset a decision should be made as to the object of treatment. If there is no reasonable chance



of cure, the treatment should be less vigorous, and the aim should be only palliation. As a rule, extensive lesions and lesions in the very old should be treated palliatively. Inoperable lymph nodes prevent the possibility of cure; operable ones, however, do not. The general condition of the patient is often the deciding factor. The presence of constitutional complications, such as diabetes mellitus, makes anything but palliative treatment inadvisable.

Two types of treatment are available, molds or implantation. The type chosen depends upon the size and location of the lesion. In general, molds are better, where they can be used. Occasionally a combination of the two is most advantageous.

The diagnosis is usually obvious. In doubtful cases a biopsy should be done. Biopsies do not increase the incidence of metastasis. The Wassermann reaction is not a differential diagnostic aid, as often both syphilis and cancer may be present. Since the response of cancer in the presence of syphilis is not good, however, it is important if the latter is present to recognize it and treat it.

Occasionally a biopsy will reveal only inflammatory tissue in the presence of a highly radiosensitive reticulo-endothelial type of tumor. Tuberculosis of the mouth frequently resembles carcinoma. A differential diagnosis may then be made only by a pathologist. Granulations around a septic root may also resemble cancer. Biopsy is very important here, as cancer may also be present. There is a frequent association of oral cancer and microcytic anemia in women. The anemia should be treated before irradiation is started.

It is important to know, in carcinoma of the palate, whether or not the antrum is invaded.

If the teeth are good, and do not irritate the diseased area, they should be left intact. Carious and tender teeth in or near the treatment area should be removed before treatment is started. Teeth should not be removed from an area which has received treatment, because of the danger of necrosis of the jaw.

Of 442 patients suffering from cancer of the mouth in all stages, treated in 1932 and 1933, 28 per cent survived for five years. Of the group with small lesions with no metastatic nodes, 62 per cent lived five years. Of those with extensive lesions with no nodes, 33 per cent; with operable nodes 18 per cent; and with inoperable nodes only 3 per cent survived five years.

In planning treatment with molds, it should be remembered that the molds must be removed for dental hygiene, meals, and during sleep. Opinions differ about the necessity of shielding parts not included in the treatment area. In certain situations it is not possible to shield all areas.

The choice of mold depends upon the size and site of the lesion. Single plane molds are used for small lesions of little depth. Sandwich molds are useful in the floor of the mouth, cheek, and lower lip.

As the molds are not worn continuously, some check is necessary on their correct reinsertion. They should be cleaned on removal, and stored where they are secure against loss or injury, and where they are well enough screened so there is no injury to attendants.

The implantation of radium is greatly aided by a good anesthetic. Intratracheal anesthesia is the most suitable type. During the immediate postoperative period special care is required to prevent pulmonary complications. Sedatives should be used. During the first three to four hours, inhalations of carbon

dioxide and oxygen should be given for ten minutes out of each hour.

The actual implantation demands skill which is only acquired with practice. Care should be exercised to see that the implants are properly placed the first time, as a second anesthetic and second placement are dangerous. The needles should be fastened so they do not come out. X-ray examination is used to see that they are correctly placed. Threading the silk attached to the needle through soft rubber tubing is of aid in preventing its fouling.

The simplest type of implantation is the single plane implantation. In this a block of tissue the size of the plane to be treated and 1 cm. thick is given the desired dose. Unless the plane is very large, it is wise to give a larger dose for single plane implantations than for other types. It is usually safe to give 7,000 r in seven to ten days for a medium-sized plane.

Multiple plane implantations or volume implants are necessary for larger and thicker lesions. Maximum and minimum doses should be in the range of 5,000 to 6,500 r in seven to ten days. Volume implantations should be used with great care because of the danger of radionecrosis.

The removal of the needles does not usually require an anesthetic. Care should be used not to break the silk attached to the needles, as they are very difficult to find if the silk is detached. Particular gentleness is required in removing the needles from the soft palate, as it tears and bleeds easily. Premature removal of the needles is sometimes required. Before this is done, it should be remembered that reinsertion will probably never be possible.

Nursing care of the patient is important. Mouth hygiene should be kept up. The patient should understand what is going to be done before treatment is started so he can co-operate. Maintenance of adequate nourishment is important and often difficult. The patient should receive 1,800 calories daily. Special high-caloric liquids may be required. During the reaction period the nourishment problem may be more difficult, but is still of great importance.

The usual reaction is a raised yellow fibrinous one, starting about the second week and lasting about six weeks. After the reaction has subsided, fibrosis frequently occurs. It is sometimes difficult to distinguish this fibrosis from recurrence. Biopsy or further treatment is dangerous.

Block dissection of the neck should not be undertaken during the reaction period. Interference with the circulation is apt to produce necrosis. Preliminary dissection of the neck and irradiation of the oral lesion as soon as the neck is healed are not advised, as the interference with circulation may seriously hamper successful radium treatment.

SYDNEY J. HAWLEY, M.D.

**Cancer of the Uterus: Results of Present Method of Radium Therapy as Influenced by Stage and Grade of Lesion.** H. H. Bowing and R. E. Fricke. *Am. J. Roentgenol.* 49: 487-493, April 1943.

Cancer of the cervix is accessible to inspection and palpation, permitting definite delineation of the stage or extent, while the microscopic grade can be determined by biopsy. As a result, an individualized plan of radium and roentgen therapy can be utilized. In a series of 1,491 cases the authors' results showed 69.2 per cent five-year cures in Stage 1 lesions, 60.2 per cent

for Stage 2, 29.7 per cent for Stage 3, and 6.5 per cent for Stage 4. The microscopic grade of the cancer has been of importance from a surgical prognostic standpoint in that patients with high-grade lesions do poorly after surgical intervention. With individualized radium therapy, lesions of grades 3 and 4 are no more fatal than lesions of grades 1 and 2.

Cancer of the uterine fundus presents a greater radiotherapeutic problem. Being a hidden lesion, it is not accessible to inspection and less revealing on palpation. Because of this, the technic of irradiation cannot be individualized to the same extent as for cervical lesions. The five-year survival rate is influenced by the stage of the lesion, varying from 93 per cent five-year cures for Stage 1 to 6 per cent for Stage 4 lesions. The data concerning patients treated from 1910 to 1938, inclusive, at the Mayo Clinic showed that, in respect to five-year survival rate, total abdominal hysterectomy with and without irradiation yielded almost similar results, 67.5 per cent and 66.6 per cent, respectively. Cancer of the uterine fundus, however, mainly afflicts women in the later age group, and other unrelated degenerative diseases often complicate the picture and increase the operative risk. Practically a third of all patients seen at the Mayo Clinic with carcinoma of the fundus were referred for irradiation alone because of the extent of the lesion and the presence of associated disease.

From their experiences, the authors believe that the extent of the primary malignant lesion of the uterus is the most valuable prognostic factor. The grade of malignant change is of prognostic significance when more standardized surgical and radium therapeutic technics are employed, though this is not so true when individualized radium therapy is employed in cancer of the uterine cervix. L. W. PAUL, M.D.

**Cancer of the Cervix: Effect on the Rate of Cure of Increased Roentgen Radiation to the Parametria.** W. P. Healy and G. H. Twombly. *Am. J. Roentgenol.* 49: 519-530, April 1943.

An analysis is given of 920 cases of primary cancer of the cervix treated at the Memorial Hospital in the six years 1932-1937. During this period the method of giving radium was practically constant, while several different schemes of external roentgen therapy were used. It was felt, therefore, that this group of cases offered an ideal set of statistics for an inquiry into the question of what value roentgen therapy may have in the treatment of cancer of the cervix and what form of roentgen therapy appears to be the most effective. The results are given in tabular form and show that when the so-called "massive dose" technic was used, a 28.5 per cent five-year cure rate followed. With the "divided dose" technic the five-year cure rate rises to 35.4 per cent. As far as could be determined, this difference was not due to the extent of the disease, the age of the patient, or the grade of tumor found to be present.

The "divided dose" technic embodies the use of six pelvic fields with a target skin distance of 70 cm. and daily doses to each of two fields of 200 r. The total dose per field was 2,000 to 2,400 r. The physical factors were 200 kv., 30 ma., and 0.5 mm. Cu plus 2.0 mm. Al filtration. An estimated three to five threshold erythema doses were delivered to the parametria for a distance of 10 to 11 cm. lateral to the cervical canal by this method. The "massive dose" technic consisted in the administration of doses of 700 to 750 r to each of four or six pelvic portals.

Other observations noted during the course of this study were that the peak in age incidence lay between forty and fifty-five years. Only 24 of the 920 patients were unmarried, and of these, 6 admitted that they had borne children. Among the foreign-born, Italians showed the highest incidence. Only 5 per cent of the patients were Jews, in spite of the large Jewish population of New York City. L. W. PAUL, M.D.

**Effect of Preoperative Irradiation on Adenocarcinoma of the Uterus.** H. E. Schmitz, J. F. Sheehan, and Janet Towne. *Am. J. Obst. & Gynec.* 45: 377-387, March 1943.

Seventy-seven patients with adenocarcinoma of the uterine fundus were treated with the aid of a Y-shaped radium filter. Of this total, 38 had preoperative and 39 postoperative irradiation. Only the former are included in this study. In 11 cases hysterectomy was subsequently performed and the effect of irradiation on the tumor and uterus was studied. Five of these patients were adequately treated, and in none of these was residual carcinoma found on serial block studies. The remaining 6 cases, all inadequately irradiated, showed carcinoma. Twenty-seven patients were irradiated, without subsequent hysterectomy. Ten of these had one or more curettages to determine the presence of active disease, and these also furnished evidence as to the value of irradiation in cases of clinical groups I and II.

All patients are curetted. The Y-capsule, containing 50 mg. of radium element in each arm, is immediately inserted into the uterine cavity. The width of the uterine fundus has been determined and the capsule opened as described in an earlier paper (*Am. J. Roentgenol.* 34: 749, 1935). After a dose of 2,000 mg.-hr., the capsule is removed. On the 8th and 16th days, the dose is repeated. This gives a total radium dose of 6,000 mg.-hr. On days when the radium is not in the uterus, the patient receives x-ray therapy; 4,000 r are applied in 10 fractions at 48-hour intervals with an 800-kv. machine, 10 ma., F.S.D. 70 cm., half-value layer 8.2 mm. Cu, 36 r per minute. Two fields, pubic and sacral, are used. If the anteroposterior diameter is 23 cm. or more, three or four fields are used. The dose attained within the pelvis after twenty-eight days was 4,000 r with back-scatter.

The authors suggest that a plan of preoperative irradiation should be followed until enough case records are available to determine whether the five-year salvage is greater in cases of preoperative or postoperative irradiation.

In the discussion which followed, Dr. Schmitz stated that 7.5 to 8 erythema doses in the uterus were given. The Y-applier was adopted to control the position of the radium in the uterus. The shifting of capsules, if placed in series in a rubber tube, cannot be prevented. Delaying the operation was no factor in the recurrence of carcinoma, if it were thoroughly irradiated. Irradiation causes no disturbance of the capillary bed. Hence, no difficulty in surgery or immediate surgical mortality should be expected.

STEPHEN N. TAGER, M.D.

**Elimination of Irradiation Injuries in the Treatment of Cancer of the Cervix.** C. L. Martin. *Am. J. Roentgenol.* 49: 494-503, April 1943.

During the past ten years an attempt has been made



in the author's clinic to eliminate the serious complications associated with radiation treatment of cancer of the cervix without lowering the total five-year survival rate. The author lists some of the technical changes, as follows: "1. Use of multiple radium sources of moderate intensity for longer periods of time. 2. Frequent shifting of the positions of radium containers of the higher intensities. 3. Heavy filtration in all radium containers. 4. Distance applicators in the vagina used with large vaginal packs. 5. Removal of all presenting tumor tissues so that a smaller total radium dosage is effective. 6. Careful approximation of radium sources to malignant tissue. 7. Copious use of green soap in vaginal preparation for radium. 8. Frequent changing of vaginal packs. 9. No radon implants used and no radium needles placed near urters. 10. Intensive roentgen therapy used only in more advanced cases. 11. Elimination of lateral portals in roentgen therapy. 12. Therapy given in one carefully planned series, and not repeated. 13. Long interval allowed to elapse between intensive roentgen therapy and radium therapy. 14. No intravaginal or perineal roentgen therapy administered."

An analysis is given of 149 consecutive unselected cases treated during the years 1936 to 1940, inclusive. The technic was individualized. Although roentgen therapy was usually given, the most effective part of the treatment was carried out with carefully placed radium applicators. In this series there were only four patients with complications possibly due to irradiation. The percentage of patients who were symptom-free with no evidence of cancer from two to six years later was 43.2 per cent. This corresponds favorably with published statistics of others. L. W. PAUL, M.D.

**An Instrument for Inserting Multiple Capsules of Radium within the Uterus in the Treatment of Corpus Cancer.** J. F. Nolan and A. N. Arneson. *Am. J. Roentgenol.* 49: 504-515, April 1943.

There is general agreement that an intra-uterine tandem of radium capsules is ineffective in most instances in the treatment of cancer of the body of the uterus. This is due to variations in shape of the cavity as a result of the tumor and the difficulty of irradiating all parts of the neoplasm equally. The effectiveness of the radium treatment may be increased by the use of a greater number of sources of radiation placed irregularly throughout the uterine cavity. Heyman's technic presents definite advantages. For this method, small, weak intra-uterine tubes are so constructed that an appreciable distance is obtained between the emanating source and the outer wall of the applicator. These tubes are packed singly into the cavity until all available space has been filled.

The authors' technic is a modified form of Heyman's method. Brass tubing was used to make sheaths of equal external diameters but different lengths. The longer ones contain 12.5 mg. sources of radium while the shorter ones hold 6.0 mg. in removable platinum cells. A special applicator has been devised for inserting these capsules into the uterus.

A preliminary report is made on the results of treatment of 69 patients seen during the period 1938 to 1941, inclusive. A notable decrease in the incidence of persistent carcinoma has been observed in those patients treated by the multiple capsule technic as compared with those treated with an intra-uterine tandem. For

the multiple capsule method there has been an increase in the total amount of radiation employed but a considerable decrease in the dose contributed by each individual source. This has resulted in less necrosis and fewer other sequelae. The uterus is known to have been perforated in one instance. In so far as possible the radium treatment has been followed by hysterectomy and the gross specimen obtained at operation has supplied material for studying the effects of the irradiation. Each patient treated with multiple capsules has been studied by means of a roentgenogram taken while the radium was in place, and this has been of value in the attempt to improve the technic. Some of the roentgenograms are reproduced. L. W. PAUL, M.D.

**Experiences with Roentgen Irradiation Following Operation on Brain Tumors.** S. N. Rowe and H. W. Jacox. *Am. J. Roentgenol.* 49: 480-486, April 1943.

The authors discuss their experiences with roentgen irradiation of gliomas of the brain following operation on the basis of a series of 32 cases; 21 of these were proved, while in the remaining 12 there was strong presumptive evidence of such a lesion. In some of the cases it was difficult to determine how much of the result was due to the operation and how much to the irradiation, but as far as could be judged, about half the patients were definitely benefited by surgical removal of the tumor or by decompression. The roentgen treatment consisted usually of exposures of 100 to 200 r given daily for approximately three weeks. If the patient's general condition and the tolerance of the scalp would permit, amounts up to 3,400 r measured in air, to one portal, and totals of 7,700 r divided among four portals were given. Subsequent series were administered chiefly when the beginning of a clinical decline indicated their need.

In approximately one-half the patients, worthwhile prolongation of comfortable and useful life occurred. In the remainder the course of the disease was not influenced by the roentgen therapy. In some of these the tumor was apparently unaffected by irradiation and continued its rapid growth. In others the patients could not tolerate sufficient treatment because of the far-advanced nature of the lesion. The best results of the combined surgical and roentgen therapy seemed to be obtained when most of the tumor was removed and intensive irradiation given without dangerously increasing the intracranial pressure.

L. W. PAUL, M.D.

**Secondary Lymphosarcoma of the Stomach.** F. Buschke and S. T. Cantril. *Am. J. Roentgenol.* 49: 450-454, April 1943.

The authors report a case of lymphosarcoma of the neck involving the right tonsil. Roentgen therapy led to complete disappearance of the primary lesion. About a year later the patient noticed a swelling of the legs and complained of some general abdominal distress. Both roentgen examination and gastroscopy showed a large ulcerating lesion on the greater curvature. The lesion was circumscribed and seemed to consist of multiple submucous nodules. The patient received 2,850 r measured on the skin in twenty-seven days. Roentgenoscopy, five days after completion of treatment, showed practically a normal stomach and this was confirmed by gastroscopy. The authors are of the opinion that this type of secondary gastric lymphosarcoma is more common than is generally

recognized, since it is likely to be obscured clinically by the presence of abdominal lymph node metastases.

L. W. PAUL, M.D.

**Lymphadenoma and Leukaemia.** A. Wilson Gill and A. J. McCall. *Brit. M. J.* 1: 284-285, March 6, 1943.

The authors present a case of lymphadenoma which was followed shortly by lymphoid leukemia and discuss the generic relationship of the two diseases.

In the case recorded there was enlargement of the lymph nodes in the neck, axilla, and groin, and roentgenograms showed mass formation about the aorta. Both this mass and the enlarged nodes responded promptly to radiation therapy and the patient was symptom-free for two years. A sudden dramatic change then became evident, with extreme anemia, an increasing leukocyte count, and a high proportion of lymphocytes. Death ensued shortly thereafter. Necropsy was not permitted. Similar cases are cited, one of which was of the myeloid type.

It has been suggested by some authors that the use of irradiation may bring about a leukemic change. The authors, however, express considerable doubt on this point. They feel that lymphadenoma and leukemia are members of a larger group of closely related diseases—the reticuloses.

Q. B. CORAY, M.D.

**Infiltration of Bone with Spontaneous Fracture in a Case of Chronic Myelogenous Leukemia.** L. M. Meyer, A. B. Friedmann, and V. Ginsberg. *Arch Surg.* 46: 514-517, April 1943.

A white woman aged 52 was seen by the authors two years after a diagnosis of chronic myelogenous leukemia had been made elsewhere. The spleen and liver were enlarged and the patient complained of weakness and backache. The white cell count was 110,000. Roentgenograms of the bones showed no abnormality. Irradiation to the kidneys and spleen, repeated from time to time, produced some benefit, but about one year after her first visit the patient re-entered the hospital acutely ill. The white cell count was elevated to 105,000 and a tender mass was present in the right thigh. A pathological fracture occurred ten days later and roentgenograms showed medullary destruction. Biopsy revealed infiltration with myeloblasts and myelocytes. Further irradiation was given, with some fall in the white cell count, but the course was rapidly downhill and death ensued about three and a half years after the original diagnosis.

The authors point out the need for repeated and complete skeletal examinations in cases of chronic leukemia.

LEWIS G. JACOBS, M.D.

**Hemangioma of Joints.** M. C. Cobey. *Arch. Surg.* 46: 465-468, April 1943.

The author adds to the previously reported cases of hemangioma of the knee joint (see Bennett, G. E., and Cobey, M. C.: *Arch. Surg.* 38: 487-500, 1939) 4 new examples. The condition is often mistaken for early tuberculosis or injury, since the principal sign is swelling of the joint. A family history of hemangioma, the presence of hemangiomas elsewhere on the body, intermittent attacks of swelling and reduction of size on elevation of the extremity are the cardinal signs of this condition. If the tumor is pedunculated, excision is the treatment of choice; otherwise roentgen therapy should be used. The technic advocated is not de-

scribed here, beyond the statement that the treatment "usually requires about one week." Weight-bearing should not be allowed for the next three months, "because roentgen therapy may do damage to the growing epiphyses in a child."

In one of the cases recorded here a pedunculated tumor was successfully excised. Roentgen therapy was employed in the other three after the diagnosis was established by biopsy and the lesion was found to be too extensive for surgical removal. Results were good in all, though one patient was followed only a few weeks.

LEWIS G. JACOBS, M.D.

## NON-NEOPLASTIC DISEASE

**Roentgen Therapy of Non-Specific Inflammatory Affections.** A. Rosslet and R. Humbert. *Schweiz. med. Wchnschr.* 73: 393-398, March 27, 1943.

After some general remarks and a historical review, Rosslet points out that the early confusion between the treatment technics appropriate for cancer and those appropriate for inflammatory conditions has led to poor results in the latter, since greater doses are required for destruction of the radioresistant neoplastic cells than are necessary in inflammations. Furthermore, the prolongation of the time spread, advantageous in cancer, is not satisfactory in inflammatory lesions, since a previous modification of the vascular bed by bacterial toxins exists. The heavy cancericidal dose frequently repeated must therefore be replaced by a single dose of the right size, or by multiple doses of small size, judiciously spaced. This dose may be as small as 6 r; it usually varies between 50 and 150 r. A single treatment may result in a cure; if repetition is necessary, a three-day interval should be allowed, especially if the inflammation be acute. The voltage may be varied with the depth of the lesion, but need not exceed 180 kv.; it should rarely be less than 50 kv. Filtration may vary from none at all to 3 mm. aluminum or 0.5 mm. copper; F.S.D. between 30 cm. and 1 meter. Many authors oppose sharp limitation of the field, believing that the absorption of x-rays in the skin has a relationship to cure. This is not improbable. In the authors' service, a dose of 100 to 150 r (each time) is given, with factors of 180 kv., 4 ma., 0.5 mm. copper filter, and 30 cm. F.S.D. Not over three treatments in five or six days are given. The general rule holds, that the more acute the inflammation the less the dose.

The authors summarize the results reported in the literature, dividing the field into five groups of cases: the suppurative affections, affections of the joints, of the eyes, genital apparatus, and bronchopulmonary tree. In general, the reported results have been good. In 291 assorted cases treated by the authors the response has been favorable in most instances.

The mechanism of the beneficial result of irradiation is still doubtful. In view of observations on irradiated furuncles, it seems as if the course of the inflammatory reaction may be hastened by irradiation. Since this effect is evidently not a direct one on the bacteria, it seems probable that effects on the white blood cells are responsible. The phagocytic power of human blood cells was tested both with and without previous irradiation, and it was, in fact, demonstrated that the opsonic index rose with doses of radiation up to 75-150 r, but fell with higher doses until, with 300 r, it was

lower than the value for unirradiated controls. Nevertheless, since many competent observers differ in the interpretation of the mechanism by which the results are produced, it does not seem profitable to debate the point; the latter speak for themselves. It is also true that certain reactions—shock reactions—play a part in the observed result. To paraphrase Pascal: "Do not rationalize the game—play it!"

LEWIS G. JACOBS, M.D.

**Treatment of Myasthenia Gravis with the Roentgen Ray.** C. D. Aring. *Ohio State M. J.* 39: 241-243, March 1943.

Following the work of Blalock, Harvey, and Lilienthal, which demonstrated the relationship of thymus gland tumors to the syndrome of myasthenia gravis, the author attempted to treat this condition with deep roentgen therapy. He presents 3 cases, in women who showed well advanced symptoms of the disease.

The first patient had a mediastinal mass which appeared to measure about 5 cm. in diameter. She was given a total of 5,400 r, 1,800 r to each of three ports (10 × 10 cm.) over the left chest. This was followed by a complete remission for three years, after which the patient was readmitted (November, 1941) because of dyspnea and substernal pain, though there was no evidence of muscular weakness or fatigability. Another course of therapy, totalling 4,000 r, was given and there had been no return of symptoms at the time of the report.

The second patient showed no evidence of mediastinal tumor. She was given 2,400 r over the mediastinum, but although she experienced subjective improvement, there was no reversal of the neurological signs. Death from an intercurrent infection occurred four months after treatment. No thymus tissue was found at autopsy.

The third patient had a history of myasthenia gravis since 1940. On re-examination in April 1942, a mass, 3 × 2 cm., was demonstrated in the superior mediastinum. Twelve treatments, totaling 1,900 r, were given through an anterior and a posterior port, with noticeable improvement. Although complete reversal of all the neurologic findings was not obtained, fatigability and weakness almost disappeared, and the patient was able to carry on her usual household duties well, without accessory medication.

Complete technical factors of treatment are not given in this article. The author believes that irradiation is the treatment of choice and should certainly be tried before the more hazardous surgical procedure of thymectomy is attempted.

SIMON POLLACK, CAPT., M.C.

## TECHNIC

**Production and Characteristics of 3,000 Kilovolt Roentgen Rays.** J. G. Trump and R. W. Cloud. *Am. J. Roentgenol.* 49: 531-535, April 1943.

By means of the Van de Graaff type of electrostatic high-voltage generator, the authors have been able to produce roentgen rays at steady constant voltages up to 4,000 kv., using air at 13 atmospheres pressure as the insulating medium. The voltage source consists of a rounded high-voltage terminal, about 2 feet in diameter, supported from the ground by a column structure of

alternate insulating and metallic spacers. An insulating belt travels at high speed within the column and transfers electric charge continuously between ground and terminal. The assembly is mounted within a metal pressure tank, so that by compression of the gas, the electrically charged belt, terminal, and column may be insulated with a medium superior to air at ordinary pressure. In operation negative electric charge is sprayed on the insulating belt at its lower end and hauled up into the high-voltage terminal, which acquires a negative potential relative to ground in direct proportion to the stored electric charge. The distribution of the ionization produced by roentgen rays over the voltage range of 1,000 to 4,000 kv. has been investigated with this apparatus.

The most outstanding characteristic at these voltages is the progressive movement of the region of maximum ionization to a depth farther below the surface as the voltage is increased. This phenomenon is termed the "subcutaneous effect" and is hardly apparent at 200 kv. It is due primarily to the increase in the number of secondary electrons in the beam as it penetrates and traverses the phantom material. The range of secondary electrons, which is negligible at 200 kv., becomes sufficient at 1,000 kv. to move the depth of maximum ionization several millimeters below the surface. Studies of depth intensity at distances of 70 centimeters and a 10 by 10-cm. field show a steady increase with voltage from 32 per cent at 200 kv. filtered with 0.5 mm. of copper to 57 per cent at 4,000 kv. filtered with 20 mm. of lead and 5 mm. of copper.

L. W. PAUL, M.D.

**Subcutaneous X-Ray Therapy: Preliminary Communication.** T. A. Watson. *Brit. J. Radiol.* 16: 113-114, April 1943.

Subcutaneous tumors, such as cervical lymph node metastases, are treated by incising the skin, dissecting it away, and irradiating the exposed node. In this manner a lethal dose may be given to the metastatic lesion without injury to the skin. The wound is closed without drainage.

The advantages are: a dose in excess of skin tolerance may be given; treatment is given to a single field; there is no skin reaction; an even dose is given to the surface of the node; an unirradiated blood supply is left over one surface of the tumor; the entire treatment is completed in one sitting.

The same principle may be applied to lymph nodes elsewhere, as in the axilla and groin.

SYDNEY J. HAWLEY, M.D.

**Time Factor in Irradiation.** G. M. MacKee, A. Mutscheller, and A. C. Cipollaro. *Arch. Dermat. & Syph.* 47: 490-497, April 1943.

The biologic response of living substances to x-rays is affected by the rate at which the radiation is given. This factor was studied by Holthusen, who plotted a curve of equivalent effects. As an example he found that equivalent erythemas were produced by 500 roentgens of high-intensity rate and 2,300 roentgens of low-intensity rate.

Various investigators have agreed and disagreed with Holthusen's findings. They are confirmed by the authors, using equivalent cutaneous reactions on the same patient as a basis for their experiments.

JOSEPH T. DANZER, M.D.

## EXPERIMENTAL STUDIES

**Effect of Roentgen Rays Upon the Growing Long Bones of Albino Rats: Histopathological Changes Involving Endochondral Growth Centers.** C. L. Hinkel. *Am. J. Roentgenol.* 49: 321-348, March 1943.

In one group of experiments by the author only female rats of normal weight and thirty days of age were irradiated. The dose was constantly 600 r (minimal stunting dose) in one sitting. The area irradiated was the right distal femoral growth center. Histopathological studies were made at sixty hours, one week, two weeks, one month, six weeks, two months, and at longer intervals. The findings at each interval after treatment are given in considerable detail. At sixty hours the entire cartilage zone is increased in thickness. This increase appears to be due to swelling of the cells. There is disorientation of osteoblasts. In the marrow spaces, there are haziness of many cells and swelling, pyknosis, and karyolysis of the marrow constituents.

At one week there are swelling of the cartilage cells and disarrangement of the cartilage columns. Marked changes are apparent in the marrow adjacent to the proximal cartilage prolongations. There is a decrease in the number of osteoblasts. Osteoid tissue in the irradiated metaphyses appears to be decreased in amount and unevenly distributed. Gross measurements at this interval show no stunting.

One month after the irradiation injury there is a significant return toward a normal appearance of the cartilage zones. The outstanding abnormality is now found in the metaphyseal and diaphyseal new bone, which is unevenly spaced and composed of spicules considerably wider and longer than normal. Gross measurements at this interval show between 1 and 1.5 mm. stunting of the irradiated femora.

Two months after irradiation there is almost complete restoration of the columnar arrangement of the cartilage cells. The marrow appears normal. Certain residual abnormalities are apparent, but these are noticed only on careful scrutiny.

Studies were also made for the purpose of examining the factors which govern the microscopic findings in any given section and considering how they exert secondary effects on each other. The most important of these factors are probably dose, age of animal at time of irradiation, and length of interval between irradiation and necropsy. In animals of the same age the effect is proportional to the dose administered, both in gross stunting and microscopic changes. In general, the degree of microscopic and gross change is inversely proportional to the age of the animal irradiated.

Probably the histopathological changes can best be explained on the basis of an immediate direct effect and a secondary or indirect influence. It appears logical to assume that the early manifestations of swelling, granularity, and loss of columnar arrangement noted very soon after exposure to roentgen rays are manifestations of direct irradiation effects upon the cartilage cells themselves. Direct effects may also account for the increased amount and granularity of the intercartilaginous matrix substance. There is no reason to doubt that the effect upon the end capillaries is a direct one. The temporary retardation of growth by roentgen irradiation produces certain modifications apparently identical with those "lines of growth ar-

rest" resulting from other causes. Irradiation effect on the blood vessels produces not only a relative anoxemia but also interference with mechanical erosive function. Avascular areas correspond to unresorbed cartilaginous remnants and these bear a close resemblance to those found in identical situations in healing rickets. Cartilage cells possess amazing powers of regeneration. If a sufficiently long time is allowed to elapse, the surviving cells regenerate and migrate distally to form a new functioning epiphyseal line. In the interval after irradiation there is a very close correlation between blood vessel recovery or regeneration and return of various growth functions. The return to normal histology is much more prompt in young animals and in the portions of the cartilage plate closest to the periosteal vessels.

Stunting, when it occurs, is apparently the result of temporary retardation or cessation of cartilage growth in a distal direction. A "line of growth arrest" is produced. This is similar to that described following acute disease in early childhood. More lasting secondary effects are explained on the basis of injury to vessels, osteoblasts, and marrow cells. At various intervals the cartilage cells tend to resume their normal relations with each other, so that months later any abnormal appearance is lost. The amount of osteoclasia and chondroclasia, which occurs proximal to the advancing line of cartilage columns, and the degree of normal anatomical restitution are directly proportional to the completeness of marrow and vascular regeneration. There is augmentation of mineral deposition in the matrix substance soon after irradiation. The metaphyseal region of bones growing after irradiation contains more mineral and more bone than normal. Study of the modifications induced in cartilage growth, matrix mineralization, osteogenesis, chondro- and osteoclasia, and blood vessel invasion may contribute to an understanding of the dynamics and physiology of bone growth.

CLARENCE E. WEAVER, M.D.

**Lung Tumours in Mice and Man.** J. Argyll Campbell. *Brit. M. J.* 1: 179-183, Feb. 13, 1943.

This is a rather comprehensive article on the relation of lung tumors to various irritating agents, demonstrating a definite relation between the findings in experimental mice and man. There is a detailed discussion of the morphology of lung tumors and also the time factors or age influence and the importance of susceptibility and heredity. A number of tables show the relative etiologic importance of various chemical agents, the most dangerous of these being radium, arsenic, a nickel dust mixture, and chromates of iron and silica. From the results obtained by research it is obvious that, so far as many of the causes of the increase in lung tumors are concerned, mice and men show a very fair agreement. The processes are of a prolonged chemical nature.

In checking the question of mechanical irritation a great deal of microscopy was done and four main degrees of deposit were demonstrated. It is apparent that dusts produce hypertrophy of lymph tissue, but there does not seem to be a very close agreement between the degree of dust deposit and the increase in lymph tissue. Bituminous coal dust and hard

steel grindings seem to be the greatest offenders, but it is apparent that the heavier degrees of dusting in the main do not control the production of lung tumor.

As regards age and sex, it seems that lung cancer is a disease of the closing years of life and males are more often affected than females. This is probably due to environmental conditions. The questions of heredity and susceptibility seem quite important in mouse experimentation, in that inbreeding leads to very susceptible or very resistant strains. One concludes therefrom that a very susceptible individual living in a moderately dusty atmosphere may be affected, while a resistant individual in a much dustier environment will escape.

Q. B. CORAY, M.D.

Effect of X-Rays on Cells Cultivated in Vitro. Part II. Recovery Factor. L. Lasnitzki. *Brit. J. Radiol.* 16: 61-67, February 1943.

In Part I of this study (*Brit. J. Radiol.* 13: 279, 1940), it was shown that irradiation of hanging drop cultures of chick fibroblasts with a dose of 100 r caused first a diminution in cell division, followed by a renewal of mitotic activity accompanied by an increase in the number of degenerate cells. At the same time the ratio of cells in different stages of mitosis was disturbed, with a predominance of cells in prophase.

In this study, also on tissue cultures of chick fibroblasts, two different doses of x-rays were used, and previously irradiated cultures were subjected to a second dose. It was found that larger doses of x-rays caused the same qualitative changes as described in Part I, while the quantitative effect was increased.

When cultures were subjected to a second dose identical with the first, after recovery had apparently taken place, the effect of the second dose was greater than that of the first. The longer the interval be-

tween the irradiations, the more nearly the effect of the second dose approached that of the first.

SYDNEY J. HAWLEY, M.D.

Effect of Ionizing Radiations on the Broad Bean Root. L. H. Gray and John Read. *Brit. J. Radiol.* 15: 11-16, 39-42, 72-76, 320-326, 1942.

In stating the aim of their experiments, in the first of this series of papers, the authors say: "We have therefore decided to obtain mortality-dose curves for the broad bean root irradiated by gamma rays, fast neutron radiation, alpha particles, and x-rays, intending to use a sufficient number of beans to reduce statistical uncertainties to a reasonable degree, and then to study the effect of combining sublethal doses of pairs of radiations, hoping that by comparison on the one hand with studies of the influence of ion density on the changes produced in specific cell structures such as chromosomes, and on the other with the influence of ion density on chemical changes, it may become clear to what extent each type of effect contributes to the death of the root." The second paper is devoted to the lethal action of gamma radiation, the third to neutron radiation, and the fourth to alpha radiations. The experiments are fully described and the method of analyzing the results is given in detail.

The mean lethal dose for gamma rays was found to be  $651 \pm 46$  energy units (or roentgens); for neutrons  $75 \pm 16$  energy units; for alpha radiation  $72.3 \pm 2.7$  energy units. Thus, when compared on the basis of ionization per unit volume of tissue, alpha radiation is about equal in efficiency to neutron radiation and nine times as efficient as gamma radiation in killing the root.

Unfortunately, since the work is apparently of fundamental importance, the papers do not lend themselves to adequate abstracting.

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# RADIOLOGY

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## Symposium on Injuries of the Head, Chest, and Back Head Injuries<sup>1</sup>

HARRY E. MOCK, M.D.

Chicago, Ill.

*The Radiological Society of North America is to be congratulated on the comprehensive program it has prepared for its annual meeting. The subject matter of the majority of these papers is exceedingly timely in this period of war. I feel highly honored to act as chairman of this symposium devoted to injuries of the head, chest, and back.*

IN INTRODUCING himself the author wishes to stress the fact that he is not a brain surgeon. Rather, he is a general surgeon who, for thirty years, has had considerable experience in surgery of trauma. Long before there were any neurosurgeons in Chicago, the victims of skull fractures and brain injuries were treated by general surgeons. Because of the nature of his practice, the author had treated several hundred serious head injuries before any specially trained neurosurgeon had entered this locality. He had started already on his hobby of collecting skull fractures. He has continued to ride this hobby until today he has records of over seven thousand proved skull fractures. Of this number, approximately five hundred have been treated by him personally.

It has been estimated that the annual crop of head injuries throughout the

United States approaches six hundred thousand. Approximately one-third of these are skull fractures. The records of the 7,031 skull fractures which have been collected and studied by the author furnish a cross section of the nation as to the principal etiological factors. Motor-driven vehicles were responsible for 50 per cent of these skull fractures, falls for 26.8 per cent, and blows for 10.3 per cent. The other 13 per cent were due to miscellaneous causes. It must be recognized at once that such potential etiological factors are scattered all over the land. Every hamlet, village, and city has its quota of craniocerebral injuries.

The majority of deaths from skull fractures—and the same is true of brain injuries without skull fractures—occur in the first twenty-four hours following the injury. In the author's series of cases 64 per cent of those dying died within the first twenty-four hours, and 60 per cent of these first-day deaths occurred in the six hours immediately following the injury. In consecutive cases surveyed from nineteen hospitals, 47 to 56 per cent of the total deaths were likewise first-day fatalities.

When one realizes that skull fractures occur all over the land—on the farm, in small communities as well as in the large centers—and when one considers the high preponderance of deaths in the first twenty-

<sup>1</sup> Presented before the Radiological Society of North America at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

TABLE I: SURVEY OF 6,262 CONSECUTIVE CASES OF PROVED SKULL FRACTURE

Survey	Total Number of Cases	Total Deaths	Range of Death Rates	Average Mortality
First: 1928-1935	3,156	1,098	25-49%	35%
Second: 1935-1940	3,106	896	17-42%	28%
Total	6,262	1,994		
Average improvement in death rate				7%

four hours, it must be recognized that head injuries will always be a problem for the general physician and surgeon. The full responsibility of saving the lives of many of these patients rests solely upon the shoulders of the medical man who first receives the case. The type of management instituted in the first six to twenty-four hours spells life or death for many of these victims.

No one recognizes better than the roentgenologist that the presence or absence of a skull fracture is of little moment in the management of head injuries and in reducing the mortality rate. It is the brain injury and not the crack in the skull that dictates the type of management and that influences the mortality rate. Many a head injury without a skull fracture will produce serious damage to the brain. Conversely, many cases give little evidence of brain injury other than a mild concussion. Few skull fractures occur, however—in the author's experience about 6 per cent—without very definite evidence of brain injury. It is for this reason that *proved skull fracture* has been taken as the measuring-rod of comparable seriousness in collecting the records of the more than seven thousand cases referred to above.

In 1940, with the assistance of Drs. John L. Lindquist, S. R. Snead, F. E. Sarver, and Harry E. Mock, Jr., the author surveyed the consecutive records from 1935 to 1940 of twelve hospitals in Illinois, Wisconsin, and Indiana, with the consent of their staffs. In addition, survey sheets from the records of twenty-six other hospitals, representing every section of the country, were filled in by a number of

surgeons. This nation-wide survey, the second the author had made of skull fracture cases, netted 3,106 consecutive records. The hospitals were labeled "A" to "S," two or three small hospitals in the same community being grouped together. Table I shows the number of cases studied in each survey and the results of management as gauged by the mortality rates. A definite improvement is apparent in the second survey.

Standards of observation and of good, average, and poor treatment were established in order to compare the management and results thereof among the 3,106 collected cases of the second survey. Each individual case record from each hospital was graded according to these standards. The average of the grades for the total series of cases in each hospital determined the management group to which the hospital was assigned. Table II shows the points on which each management group was graded. The mortality rate found in each group justified these grades.

Further analysis of the nineteen hospitals that treated these 3,106 consecutive skull fractures during a five-year period revealed that the injuries were of equal seriousness judged by the relative proportion of linear, basal, and combined fractures. The staffs of four of these hospitals so managed 323 cases that the mortality rates ranged from 17 to 21 per cent. The staffs of five so managed 2,033 cases that the mortality rates were 23 to 29 per cent. But the staffs of ten hospitals rendered such poor management in 750 cases that death rates mounted to 30 to 42 per cent.

"Consecutive cases—not picked cases—of equal seriousness and treated in the average run of hospitals in the United States—hospitals where your wife or mine would be taken for treatment if injured while making an automobile tour of the country! Why this wide divergence in results?"<sup>2</sup>

<sup>2</sup> MOCK, HARRY E.: Management of Skull Fractures and Brain Injuries. J. A. M. A. 120: 501, Oct. 17, 1942.



TABLE II: GROUPING OF HOSPITALS ACCORDING TO GOOD, AVERAGE, AND POOR MANAGEMENT

Number of Cases and Points Determining Grading	Good A to D	Average E to I	Poor J to S
Number of Consecutive Skull Fractures	323	2,033	750
Mortality Rates	17 to 21%	23 to 29%	30 to 42%
Observation: Average Grade	85%	75%	54%
Treatment: Average Grade	82%	60%	35%
Shock Rules Observed	85%	70%	45%
Dehydration, when Used, was Adequate	90%	70%	38%
Spinal Tap, when Indicated, Done Early (1st 24 hours)	78%	50%	20%
Spinal Fluid Drainage Sufficient (20 to 70 c.c.)	80%	45%	18%
Operative Judgment	78%	80%	50%

## OBSERVATION

If in every instance of severe craniocerebral injury one could lift the cranial cap and actually see the pathologic changes in the brain and in its blood and cerebrospinal fluid circulations, the management of the case would be simplified and many controversial problems concerning treatment would be solved immediately. But the surgeon viewing the unconscious patient with a severe head injury must depend on the signs and symptoms, rarely stationary, more often showing changes in variety and intensity, if he is to approach even an approximate diagnosis of the pathologic changes inside that skull.

The changeability of the signs and symptoms and the importance of recognizing and interpreting many of these changes furnish the strongest argument for close observation and charting the course. The value of close observation is reflected in the mortality rates of the good, average, and poor management groups in Table II. The grade of 85 per cent for observation in the good management group means that with few exceptions every case record had the blood pressure, pulse, respiration, and temperature charted at least every two hours and in many instances as often as every thirty minutes. This "charting of the course" indicates that the surgeons were in control of their cases at all times. The observation grade of 54 per cent in the poor management group represents a far different situation—blood pressure often neglected, and pulse, respiration, and temperature charted only two or three times a day. Such charting indicates poor navigation.

## X-RAY EXAMINATION

*Every head injury case should have an x-ray examination, but never in the presence of shock, deep coma, or wild delirium.* Years ago the author made a poster embodying this slogan and this has hung in x-ray departments in various hospitals throughout the land. Exceptions to this rule may occur when badly depressed comminuted fractures are suspected or when an extradural hemorrhage is suspected and the surgeon is anxious to know if the fracture line crosses the middle meningeal artery. In such instances a portable apparatus should be used rather than subject the patient to the added insult of moving him to the x-ray laboratory and turning him in the multiple positions necessary for a comprehensive study of the skull. The question may well be asked: "Why x-ray the remaining cases if the crack in the skull is of no moment?" The medicolegal aspect is obvious but certainly not the chief reason, as stressed by many authors. If the late roentgenogram shows a fractured skull, the wise surgeon will recognize the potentialities of greater brain damage and will keep the patient quiet in bed and under close observation for a longer period than if he had a head injury without fracture. Furthermore, the x-ray may reveal a depression that was not suspected on palpating the skull or it may show the presence of an aerocele. There are plenty of reasons why an x-ray study should be made, but few reasons why it should be made during the period when it is adding insult to injury.

From 1933 cases from our second survey in which the record indicated the time of

TABLE III: DEATH RATE CORRELATED WITH TIME OF X-RAY EXAMINATION IN RELATION TO INJURY

	X-Rayed	First 6 Hours	Deaths	6-24 Hours	Deaths	2nd Day	Deaths	Later	Deaths
Good Management	238	53 (22%)	3.8%	74 (31%)	12.2%	19 (8%)	10.5%	92 (39%)	4.3%
Average Management	1,151	188 (22%)	12.2%	337 (30%)	6.2%	190 (16%)	4.7%	436 (38%)	6.2%
Poor Management	544	181 (33%)	19.3%	215 (39%)	13.0%	50 (9.8%)	20.0%	98 (18%)	7.1%

taking roentgenograms, Table III was developed. This table shows the increased tendency to x-ray the skull immediately or in the first few hours in the poor management group as compared with the average and good management groups. It also shows the increased mortality rate of early as compared with later roentgen examinations.

denced by the 7 per cent improvement in mortality rates in the second of our two nation-wide surveys. The above indictment is warranted if it will stimulate more of us to reduce the high mortality rate from brain injuries.

The management which will produce better results and lower mortality rates in brain injuries is epitomized in Table V.

TABLE IV: RESULTS OF X-RAY EXAMINATION

	Total Cases	Deaths	Total X-Rayed	X-Ray Positive	X-Ray Negative	No X-Ray
Good Management	323	19.7%	238(73.6%)	220(92.4%)	18(7.6%)	85(26.3%)
Average Management	1,747	29.9%	1,151(65.9%)	928(80.0%)	223(20.0%)	596(34.1%)
Poor Management	750	33.3%	544(72.7%)	489(89.0%)	56(11.0%)	205(27.3%)
Totals	2,820		1,933(68.6%)	1,637(84.7%)	297(15.3%)	886(31.4%)

Table IV indicates the total number of patients x-rayed in each management group and the number of positive and negative x-ray findings. In the cases not examined roentgenographically and those with negative films, proof of skull fracture was indicated in the record by bleeding from the orifices or as shown at operation or autopsy.

#### TREATMENT

After conscientiously analyzing the 3,106 consecutive proved skull fracture cases collected, and especially the 750 consecutive cases treated in the *poor management group*, the author is convinced that 50 per cent of those dying in the hospitals where the poorest handling of skull fractures was apparent might have been saved by closer observation of each individual case and by adherence to well established rules concerning the care of these patients. All of us in the profession are slowly learning these rules of management and are making better use of them, as evi-

TABLE V: MANAGEMENT WHICH GIVES IMPROVED RESULTS

1. Treat cerebral shock first.
2. Avoid adding insult to injury.
3. Chart course hourly. Live with the patient.
4. Blood transfusion for persistent shock or severe associated injuries.
5. Oxygen early for persistent unconsciousness, cerebral anoxia, threatened respiratory failure, or associated chest injuries.
6. Postural drainage or aspiration.
7. Adequate dehydration; spinal drainage; operation—each when and if indicated by signs and symptoms.
8. Avoid overdehydration. Maintain fluid balance without pushing fluids. Prolonged dehydration may be the cause of death.
9. Do spinal puncture early when indicated. Drain adequate amount of fluid. Early operation seldom indicated.
10. Maintain nutrition. Feed by stomach tube if necessary.
11. Avoid oversedation. Seldom, if ever, use morphine.
12. Consider the patient, not the family or the surgeon's convenience.

Time will not permit greater detail concerning the indications and methods for

dehydration, spinal drainage, and operations in skull fractures and brain injuries. Those who are interested will find a more detailed account of management in the *Journal of the American Medical Association*, Oct. 17, 1942. The point to be emphasized here is that the high mortality rate from skull fractures can be reduced by every physician and surgeon who treats these cases. The author's mortality rate twelve and ten years ago varied from 20 to 21 per cent. He has reduced it to 16.7 per cent. In Table II he has graded nineteen hospitals scattered from New Hampshire to Texas, and from Washington to Florida, including small rural hospitals, private hospitals in medium-sized and large cities, and a few large county hospitals, in which the number of consecutive skull fracture cases treated during this five-year period varied from 20 to 1,500. The mortality rate in the best of these hospitals was 17 per cent, whereas the hospital showing the poorest results had a death rate of 42 per cent. Four hospitals made up the *good management group*, with an average mortality rate of 19 per cent. Five hospitals constituted the *average management group*, with an average death rate of 25 per cent. Ten hospitals belonged to the *poor management group*, with an average mortality of 38 per cent. Remember, these were consecutive cases—not picked cases—of equal

#### TABLE VI: WHAT CAUSES DEATH IN SKULL FRACTURES?

##### **PATHOLOGICAL (10 to 12% inevitable)**

1. Cerebral shock.
2. Massive brain lesions.
3. Small hemorrhages in vital centers.
4. Serious associated injuries.
5. Complicating diseases.

##### **MISMANAGEMENT (5 to 50% preventable)**

1. Failure to treat shock first.
2. Failure to observe and "chart the course."
3. A "hit-and-miss" type of dehydration.
4. Overdehydration and starvation.
5. Too few or too late spinal punctures.
6. Too few, too many, and too early operations.
7. Oversedation.

seriousness and treated in the average run of hospitals in the United States. Ask yourself the questions: "Into which hospital would I want my wife or child taken for treatment if injured while making an auto tour of the country?" "Why does the staff of one hospital save 83 per cent of its skull fracture cases while another hospital, receiving approximately the same proportion of linear, combined, and basal skull fractures, with approximately the same proportion of associated injuries, saves only 58 per cent?" The answer to this last question is graphically shown in Table VI.

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# Some Considerations Concerning the Roentgen Diagnosis of Skull Fractures<sup>1</sup>

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Detroit, Mich.

IN THE PAST eighteen years at the Detroit Receiving Hospital we have examined roentgenographically over 50,000 skulls to determine the extent of injury. Of this number, about 9,000 have shown fractures. We feel, therefore, that some suggestions concerning the diagnosis of skull fractures can be made.

To give the examination the widest application, we have utilized a simplified technic of four projections for all patients having signs, symptoms, or history of skull injury. Right and left lateral, frontal, and occipital views are obtained. The use of the smallest possible focal spot, Bucky diaphragm, and precision in technic are considered essential. It is not until we find that a questionable line exists, or that a probable fracture has not been demonstrated, that additional films are taken. In many of our cases, injury is so trivial that more exhaustive studies would be too time-consuming and expensive for routine use. In those cases where additional films are required they are taken with greater precision and with less distress to the patient due to the longer lapse of time. Their specific purpose is to show the suspected area in the greatest detail and with the least superimposition. Ginsburg has given an excellent review of the possibilities and limitations of the various special views. By following the course just outlined, we have found that our accuracy of diagnosis has been at a very good level and much time and money have been saved. Exhausting initial examination may do harm to the patient.

We have arbitrarily divided our skull fractures into three groups: (1) those in the anterior third, including all of the

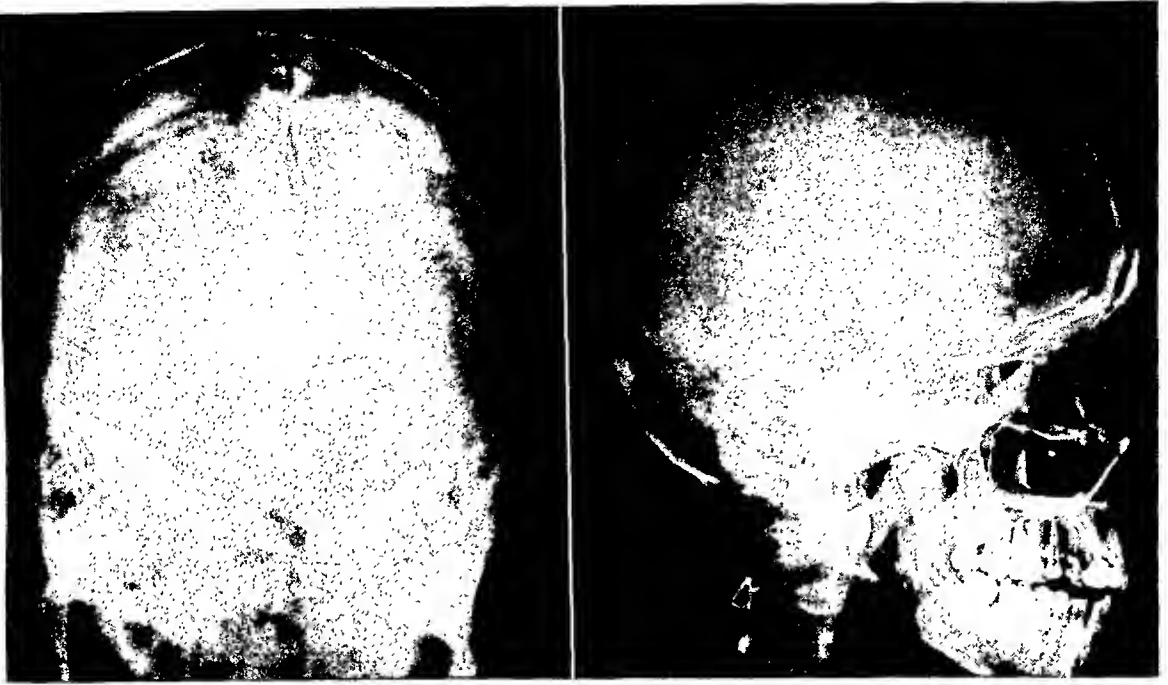
frontal area; (2) those in the middle third, including the parietal, sphenoidal, temporal, and mastoid areas; (3) those in the posterior third, including the occipital bone. An analysis has shown that 26.8 per cent of all fractures occur in the anterior third, 45.3 per cent in the middle third, and 27.9 per cent in the posterior third. This includes all of the various types: linear, stellate, comminuted, depressed, and diastatic. These figures have been substantiated by Rand, Rendich, Ehrenpreis, Stewart, and others. At our clinic the mortality is seen to parallel this incidence, being reasonably low in the frontal and occipital regions, and increasing rapidly as the fracture line extends laterally and downward toward the mastoid. Unfortunately, too, fractures in this latter region are the most difficult to detect.

The establishment of a proper diagnosis is, of course, the first consideration. Not only is the presence of a fracture line of importance, but also its extent and the possibility of involvement which may contribute to complications. These matters are deserving of most careful deliberation and co-operation between the roentgenologist and the attending physician.

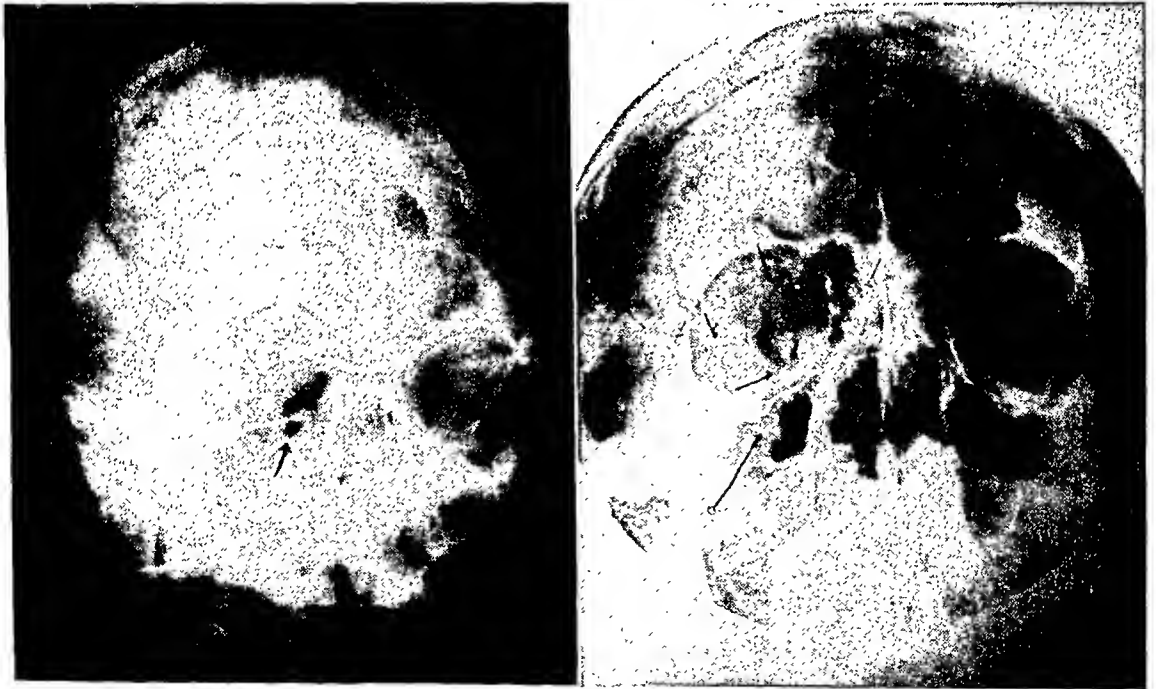
Linear fractures are the chief source of worry in differential diagnosis. Any sharply etched linear shadow which shows a dissolution of the continuity of the fine osseous structure may represent a fracture. As is well known, differentiation must be made from suture lines, diploic markings, vascular grooves, and artifacts. Linear fractures are generally darker in appearance than any of the other markings. Their course is usually not that characteristic of vascular markings, but may be so, (Figs. 1 and 2).<sup>2</sup> Vascular markings radi-

<sup>1</sup> Presented, as part of the Symposium on Injuries of the Head, Chest, and Back, before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

<sup>2</sup> All examples shown were proved either at operation or autopsy.



Figs. 1 and 2. Showing close resemblance roentgenographically between vascular grooves and fractures of skull. Fig. 1 (left) shows a branching line of decreased density closely simulating a fracture of the occiput. Autopsy revealed no evidence of fracture but showed prominent vascular grooves. Fig. 2 (right) shows a fracture of the middle third of the skull simulating a vascular groove.



Figs. 3 and 4. Routine orbital view showing no involvement of the orbit and antral view revealing marked extent of fractures involving the orbit. The patient became blind three weeks following injury.

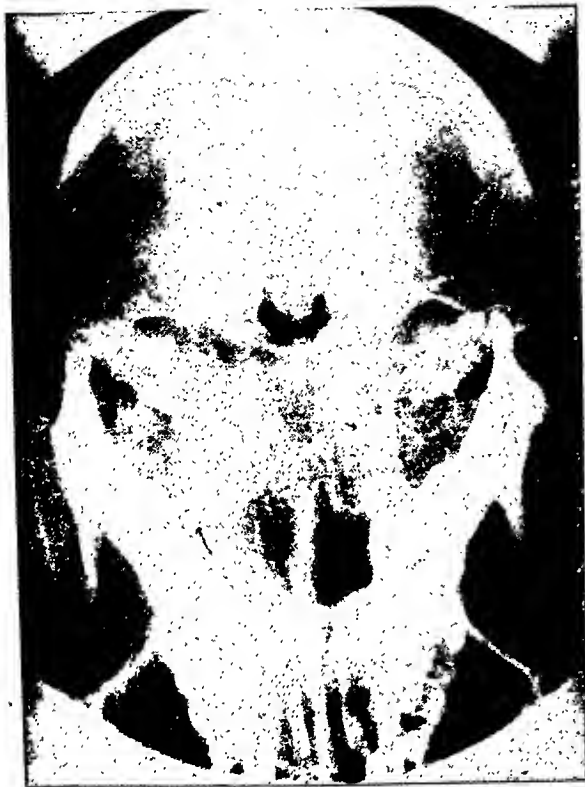


Fig. 10. Extension of fracture from right temporal region across the base of the skull, involving the ethmoid and mastoid on the opposite side.

views are obtained (Figs. 8 and 9). Mastoid fractures have been classified as transverse and longitudinal. The longitudinal fractures generally involve the auditory meatus and tympanic cavity. It is rare that the membrane remains intact in such injuries. More often than is ever suspected, the fracture lines will be a combination of both types, and extend across the base of the skull toward the opposite side (Fig. 10). Such fractures, particularly the transverse element, almost always involve a break in the capsule. The mortality is increased as the mastoid shows greater involvement. The association of deafness and vestibular phenomena are too often neglected. Deafness may be the result of hemorrhage into the middle ear or edema of the nerve secondary to injury. It may result in a permanent defect. Semicircular canal involvement often produces profound and protracted symptoms.

Mastoiditis as a complication may be

seen early or late. With the involvement of the capsule, bony non-union is almost invariably the result. We have several cases to substantiate this. One fracture was demonstrable sixteen years and another twenty years after the original accident. These defects are a constant source of danger to the patients (Figs. 11

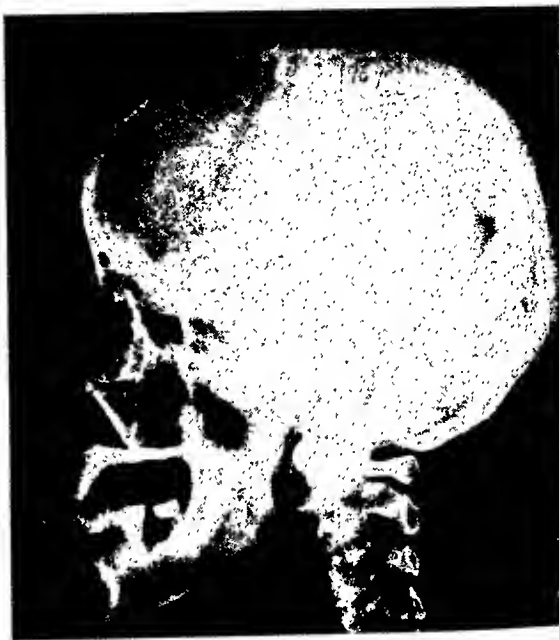


Fig. 11. Fracture of mastoid with non-union. The patient suffered injury sixteen years previously with no complications; he entered the hospital recently with acute meningitis which had its source in the fractured mastoid.

and 12). Other complications subsequent to fracture in the middle third, to mention only a few, are: diabetes insipidus, hypotension, facial paralysis, amnesia, aphasia, arteriovenous fistula, and injury to the abducens.

In fractures of the posterior third, or occipital bone, complicating features are at a minimum and involvement of the foramen magnum at our clinic has not seemed to be of too great consequence. The projection of a metopic frontal suture, the occipital condylar articulations, and the lambdoid suture markings sometimes confuse the picture, particularly in young patients. The accurate estimation of diastatic fracture is a matter of judgment and experience here and elsewhere.

We would say a word concerning the healing of fractures. A review of the literature reveals no constant agreement. In the skull, as elsewhere in the body, the ordinary linear fracture in the child will heal readily, generally in from four to twelve months; in adults eight months to two years are required. Comminuted and depressed fractures heal with a rapidity dependent upon their extent and the amount of "reduction." Gaping and diastatic fractures, particularly over the dome of the skull, are slow to heal. Some have been detected as late as eight years subsequent to injury. Occipital fractures heal slowly only because of the thickness of the bone. In our experience, fractures of the mastoid, in most cases where a follow-up has been possible, have shown bony non-union, and the mortality, both immediate and remote, has been found to depend upon the extent of fracture.

The time interval for union has become most important medicolegally since the advent of the automobile and will become even more so subsequent to the present highly motorized war. Vance states that an old linear fracture can be differentiated from a new one after eight months' time. In general, we would agree, except in some cases of mastoid fracture and in the base of the skull, where even the most exacting examination has failed to reveal an absolute difference.

#### SUMMARY

Over 50,000 cases of skull injury have been examined at the Detroit Receiving Hospital.

The initial roentgen examination includes four routine views, with subsequent views of suspected areas. The importance of these special studies is emphasized.

Skull fractures are divided arbitrarily into three groups, depending upon the area of involvement. In this series 45.3 per cent were in the middle area, or temporo-mastoid region. Fractures in this region are more easily missed and complications are more serious than elsewhere in the skull. Some of the difficulties of diagnosis are



Fig. 12. Fracture of temporal region. The patient was first seen in November 1942 with injury over the temporal region but no evidence of fracture in routine views. On readmission, in June 1943, with injury to the jaw and a stab wound in the abdomen, examination revealed the evidence of an old fracture involving the mastoid. Review of the earlier films showed evidence of fracture by retrospect only. This illustrates the importance of mastoid involvement.

discussed and the importance of the time interval for healing with reference to differential diagnosis and the medicolegal aspects is suggested.

We wish to extend our thanks to Dr. E. S. Gurdjian for his help and criticism.

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# The Management of Jaw Fractures<sup>1</sup>

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THE MOST frequently fractured of the facial bones is the mandible. Pathological fractures, the indirect result of disease, are not uncommon, but the majority of mandible fractures are traumatic. The advent of the high-speed automobile has changed our ideas of the etiology of fractures of the facial bones but, with rubber and gas rationing and reduced speeds, this hazard will be largely eliminated, at least for the duration, and fists and falls will probably take first place as causes of mandible fractures in civilian practice. War injuries, unfortunately, will be of severe type, taxing the skill and ingenuity of the surgeon.

Fractures of the mandible may be partial, involving the alveolar processes or individual teeth, or they may be complete and of the same varieties as fractures of other bones—single, double, or comminuted.

Single fractures occur most frequently, predominating over double fractures in the ratio of two to one. They are located at the angle or the mental foramen. Of the double fractures, those occurring at the angle on one side and mental foramen on the other are by far the most common (about 75 per cent). Fractures in the region of the symphysis menti or condyle are less frequent. The sites of predilection, in the order of their frequency, are the angle, mental foramen, molar region, symphysis, condyle, and coronoid process.

Areas of anatomic weakness in the mandible determine the location of a fracture. In children with unerupted teeth the cuspid region is most frequently the site of fracture. Fractures of the body of the mandible when teeth are present are invariably compound.

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The diagnosis of fracture of the jaw is usually not difficult. There is a history of injury and the patient often presents a characteristic appearance; the head is carefully held, with the mouth open and an increased flow of saliva and drooling because of pain elicited by the muscular pull on fragments and a natural disinclination to swallow. There is some swelling; localized pain is variable but may be severe. Difficulty in opening or closing the jaws may be due to disinclination or to the displacement of fragments. Because of this displacement, the alignment of the jaws may be disturbed, with abnormal occlusion of the teeth. Anesthesia of the lower lip and gums may be discovered.

Unnecessary movement of parts should be avoided, but crepitus may be elicited and a false point of motion felt. X-ray examination is the best means of determining the extent of injury. It is possible to examine the entire mandible from the temporo-mandibular joint on one side, around the jaw, to the joint on the other side, and this examination should be made in every case.

## TREATMENT OF FRACTURE OF THE MANDIBLE

The objectives of treatment are the care of the injured soft tissues to prevent or minimize infection and the reduction of fragments to normal position, which usually results in the restoration of occlusion of the teeth. The restoration of the normal tooth occlusion is of the greatest importance in gaining a good functional result. The teeth will act as landmarks for successful reduction and will provide points of fixation for wires or other appliances which may be indicated. Thorough cleansing of the mouth and teeth should be done before any attempt is made to reduce fractures. This entails the irri-

gation of lacerations and the removal of calculus from the teeth in order to make as clean a field as possible. The use of a suction tube with a small nozzle will be a great aid in cleansing wounds of debris and blood clots, in effect a minor débridement.

Broken teeth, teeth in the line of fracture, partly avulsed teeth, and fragments of bone in comminuted areas should be regarded with concern and suspicion. At the same time, it is imperative that no viable bone be removed and, after study of the problem involved in retaining the fragments in position, that no tooth be removed that may be of aid in fixation. Many fractures have been complicated by the unconsidered removal of every loose or apparently useless tooth.

Often teeth may be retained, with distinct advantage, even though some degree of infection must be overcome. It is a well known fact that repair goes on in the mandible even where severe infection exists (osteomyelitis), provided adequate drainage is maintained. The patient should be encouraged in mouth irrigation or the use of mouth washes.

When the soft tissues have been cared for, attention is directed to reduction and fixation. Before the days of Hippocrates fractured jaws were treated by ligatures and splints. Dr. Thomas L. Gilmer, in 1887, used the sound jaw as a splint and articulated the teeth of the fractured fragments with the teeth of the sound jaw by means of wires. With some modifications, this method is in use today and still is the simplest and most generally satisfactory way by which a fractured jaw can be immobilized after reduction. A variation of this method is to ligate arch bars of fairly stout wire (16 gauge) to teeth in both jaws and connect them firmly with wire ligatures or by means of elastic bands. More recently there has been a trend toward the use of pins, nails, or screws. These methods are sound and of great value, especially in the treatment of multiple fractures, refractory fragments, and edentulous jaws. Open reduction and direct wiring or plating are to be avoided.

The methods outlined above should be used under strict asepsis and with a knowledge of the osteology of the structures involved. The advantages of this form of treatment are that the mandible is free to function, mouth hygiene is improved, feeding is simplified, and the comfort of the patient is greater. With the observance of strict surgical asepsis, watchful aftercare, and good technic, there appear to be no disadvantages. We have never had a patient who complained seriously of the ligation of the two jaws. The older methods of intermaxillary wiring are often used as secondary aids and will not be discarded.

Splints are undoubtedly of great value in the treatment of some cases, particularly where there is loss of bone. To support jaws where bone grafting is indicated their use is imperative. The construction of splints, however, is time-consuming and they are useless unless carefully and expertly made. Impressions of the jaws are often difficult to obtain and if they are not accurate the results are not good. The setting of the splints may tax the resources of the surgeon when he attempts to assemble the fragments to the splint. We have made splints and have had to discard them for this reason. Perhaps our technic was not good, but we do know that 80 per cent at least of all mandibular fractures can be successfully treated by the simpler methods. In an excellent book by Ivy and Curtis the use of splints is discussed very fairly.

#### FRACTURES OF THE MAXILLA AND FACIAL BONES

Automobile accidents have increased the incidence of maxillary fractures. They occur on the farm as a result of the greater use of machinery and from the kicks of animals. Accidents in industrial plants, also, frequently result in upper jaw and facial injuries. One of our chief concerns at present is the care of such injuries suffered by the armed forces. While maxillary fractures have a lower incidence than those of the mandible, they often present more

acute problems in treatment, since they may be related to head injuries and fracture with displacement of one or all of the facial bones.

Ivy and Curtis classify maxillary fractures as follows: (1) Fracture of the alveolar process alone; (2) unilateral fractures across the facial aspect, above the roots of the teeth and through the hard palate; (3) bilateral horizontal fractures above the palate and below the orbital plates; (4) extensive comminution and crushing of the upper part of the maxillae, complicated by fracture of the nasal and other bones.

Blair *et al.* in discussing early local care of face injuries say of maxillary fracture: "Considered in relation to fractures, the term maxilla includes all the bones of the face with the exception of the frontal bones and the mandible—all together, including the lachrymal and the lateral masses of the ethmoid, vomer and parts of the sphenoid, forming one integral mass, in which fracture lines disregard anatomic boundaries. In treatment, a distinction exists between the more solid tooth-bearing part of the maxilla and the more articulate framework of the superstructure."

The success in treatment of these injuries is in direct proportion to the early and proper care the patient receives. It is not enough to succeed in realigning the jaws and restoring the occlusion of the teeth. Displaced fragments of bone, unrecognized or ignored and not returned to normal position, make for deformity, which may be difficult or impossible to correct later.

In treating fractures of the maxillary bones and related structures, the method to be used is best determined after careful radiographic and clinical examination has been made. The more accurate and painstaking the details of the plan evolved, the more likely is a proper solution of the problem to be obtained. Casts made of the displaced fragments may be of great aid in diagnosis and facilitate the making of appliances which may be necessary.

Simple intermaxillary or interdental wiring may be sufficient in some types of max-

illary fracture. Fractures of the alveolar process and unilateral fractures of the palate can be treated in this way. Spreading mid-line fractures of either upper or lower jaw have been satisfactorily treated by us with the simple wire arch suggested by Risdon.

Complete horizontal fracture of the maxillary bones may show very slight or gross displacement. In the former case, a rubber dam bandage stretched to a plaster head cap from beneath the mandible will sometimes restore occlusion and hold the maxillary fragments securely in place. In the more severe displacements a reversed Gunning splint may be used, but we have had more satisfaction from the method of Teterspiel, who passes wires through the cheeks. These wires pass from arch bars within the mouth to outrigging incorporated in a plaster head cap. No scars are left if the wires are placed carefully, and they cause no tissue reaction.

The most serious maxillary fractures are those in which crushing and comminution of the upper part of the face are associated with complete horizontal fracture. The maxillae are separated from the base of the skull, which may also be fractured. Supportive treatment is indicated and there should be no haste in reduction or repositioning of fragments, since infections are common and meningitis a real danger. During the time of waiting, provision for drainage may be made and normal saline irrigation used frequently to cleanse the tissues. Fixation is accomplished by rigid connections between a reversed Gunning splint and a plaster head cap, adjusted to restore the full vertical dimension of the face.

Fractures of the maxillae are often associated with fracture and gross displacement of the nasal bones and of the zygoma and zygomatic arch. These fractures are common in automobile accidents and are always the result of severe blows. Diagnosis is usually to be made on the basis of disturbed facial contours and digital examination, but swelling may mask the extent of the injury. Radiographic examination is very valuable.

Except in the case of ethmoid involvement, when delay in manipulation or reduction is imperative to minimize danger of meningitis, nasal fractures should be reduced as soon as possible. For good reason, however, a delay of two weeks can be allowed.

The impacted fragments should be released and the reduction of all fragments made, the nose being molded to form by intranasal elevation and external pressure with the fingers and thumb. Insertion of the rubber-protected blades of a large Kelly forceps in either nostril will allow of internal manipulation. The septum must be replaced and retained in its relation to the vomer. If the nasal bones are spread they must be replaced to restore the proper space relation at the inner canthus. This procedure and the care of nasal mucosal tears are of great importance.

Light intranasal packs and firm external splints are usually sufficient for retention. It may, however, be necessary to provide support for the nose, in which event an internal splint attached to the upper teeth may be advisable. To hold the fragments forward it may be necessary to pass wires through the nasal bones, secured around external pads.

Fractures of the zygoma and zygomatic arch are relatively uncommon, but always present problems of treatment. Displacement may occur in any conceivable direction and may be accompanied by extreme swelling, disturbance of facial contours, interference with mandibular movements, crushing of the antrum and laceration of the mucous lining, facial anesthesia, diplopia, ecchymosis, and emphysema. Reduction is done as early as possible following in-

jury, and means of using leverage to restore displaced fragments are employed. Many methods are in use, that of Gillies of London being perhaps the most effective and popular. He passes a suitable instrument from an incision within the hair line, between the temporal fascia and the temporal muscle, to the area beneath the zygomatic arch and proceeds to move and adjust the fragments in position. In the event that the orbital rim is fractured, with an accompanying displacement of the orbital floor, it may be necessary to open the antrum and pack to maintain this structure in position. When facial structures are reduced satisfactorily, it is not often necessary to wire or otherwise immobilize fragments, as there is no muscle pull to affect them.

Feeding is an important consideration in the care of patients with jaw fractures. Generally speaking, the diet should be nourishing and of adequate vitamin content, and will vary from liquid to soft, depending upon the method of immobilization used. The caloric requirement will be between 2,000 and 3,000. It may be said that any well balanced diet may be made available to these patients by proper and suitable preparation, which means that, in addition to actual liquid nourishment, meats must be finely ground, vegetables and fruits pureed, soups and broths strained. In fact, all food prescribed must be capable of easy passage through a feeding tube by easy suction. Spoon feeding may be employed. Occasionally it is necessary to use nasal feeding.

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# The Roentgenologic Diagnosis of Chest Injuries<sup>1</sup>

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## Introduction

Before continuing this symposium with a discussion of chest injuries by Doctor Bennett, I wish to refer once more to the 3,106 consecutive skull fracture records collected in my second nation-wide survey. In studying the injuries associated with skull fractures it was apparent that chest injuries were the most serious. The association of multiple fractures of the ribs with skull fractures resulted in an appall-

ing increase in mortality rates. The death rate increased from an average of 19 per cent to 28.5 per cent in the good management group; from 25 per cent to 37 per cent in the average management group; and from 34 per cent to 65.5 per cent in the poor management group.

Chest injuries, always serious, are especially so when associated with brain injuries.

HARRY E. MOCK

THE ROENTGENOLOGIC findings in chest injuries range from very slight to exceedingly extensive, depending largely upon the nature of the traumatizing agent and upon its force, penetration, and course. In some cases there may be merely evidence of soft tissue swelling, with no sign of fracture or of intrathoracic damage. In other cases one or more fractured ribs may be found, without evidence of deeper injury. The importance, in the study of ribs, of having a number of views is well known, as a fracture may be completely obscured when the beam is tangential to the curve of the involved rib. This is particularly prone to occur in the axillary regions. It is well to bear in mind that when the injury is anterior there may be a fracture of a cartilage which will not be revealed on the roentgenogram unless the cartilage is calcified. Such cases are difficult to prove but I have seen instances where there was reason to believe that such a lesion was present, or, in some cases, separation at a costochondral junction. In other cases, there may be a fracture of the sternum. Lateral or oblique views are required to demonstrate

this. The necessity of such views is indicated by the physical findings. The normal separation between the manubrium and the corpus of the sternum should, of course, not be confused with a fracture. If care is not taken, occasional irregular calcification in the cartilages protruding anterior to the sternum in the lateral view may also be confusing.

In study of the routine chest film, observation of the osseous structures should never be omitted. Occasionally, in a patient giving a history of pain in the chest but denying trauma, a roentgenogram will reveal one or more fractured ribs. At times even a fractured dorsal vertebra may be suspected from the chest film. A localized decrease of the vertebral aspect of the intercostal spaces—even where the vertebral outlines are indiscernible—may be the first clue to a fracture of a dorsal vertebra. An antero-posterior and lateral view of the spine centering over this area may then reveal the compression fracture.

Varying degrees of subcutaneous emphysema may be observed on the film (Figs. 1 and 6). At times this may be the only evidence of a perforated lung. If the perforation is slight, there may be no demonstration of a pneumothorax, especially in certain phases of respiration, and yet considerable air may be present in

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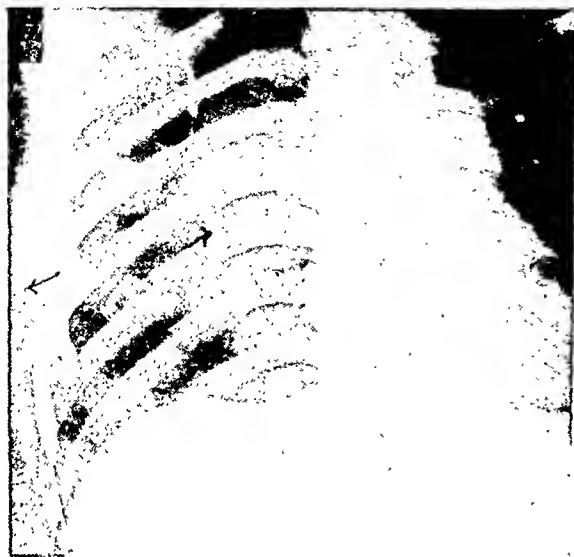


Fig. 1. Case of fractured ribs, extensive pneumothorax, and subcutaneous emphysema.

the soft tissues. This is particularly true of stab wounds, where ordinarily there is no evidence of associated rib fracture. Usually, when the pulmonary trauma is below the level of the clavicle, the subcutaneous air, if moderate in amount, is located unilaterally—on the traumatized side only. If the injury is in the apices or trachea, there may be air on both sides. Differentiation must, of course, be made from gas due to a gas-forming organism, but as a rule this is not difficult. The air can be readily demonstrated on physical examination by the characteristic tissue-paper crepitation, but the roentgenogram adds information as to its amount and extent.

Pneumothorax may be present with or without fracture of the ribs (Fig. 1). In stab wounds the ribs are ordinarily not involved, and often the only roentgenographic evidence of trauma may be a pneumothorax. In wounds due to projectiles there may frequently be severe associated damage to the osseous thorax. Cases have been reported of partial or complete pneumothorax without an external wound, due to the proximity of a bomb blast, with rupture of the lung surface. I have seen one case of a bilateral pneumothorax in a man who jumped into the river in a suicidal attempt. A small

amount of air was seen in either pleural cavity. Possibly a change of mind, with a desperate inhalation in an effort to avoid drowning, was responsible for the perforations.

A pneumothorax may be so slight as to be barely perceptible, and films in both inspiration and expiration may be required to demonstrate it. On the other hand, it may be so extreme as to cause complete collapse of an entire lung, with displacement of the mediastinum and occasionally herniation. In some cases the increased pressure of the air in the pleural cavity may be such as to result in severe cardiac embarrassment and ultimate failure. It should be borne in mind that air in the pleural cavity does not necessarily imply perforation of the lung; it may in some cases enter through a wound from the outside, being drawn in with every expiratory movement. The reverse, of course, is true when communication exists between the lung parenchyma and the pleural cavity.

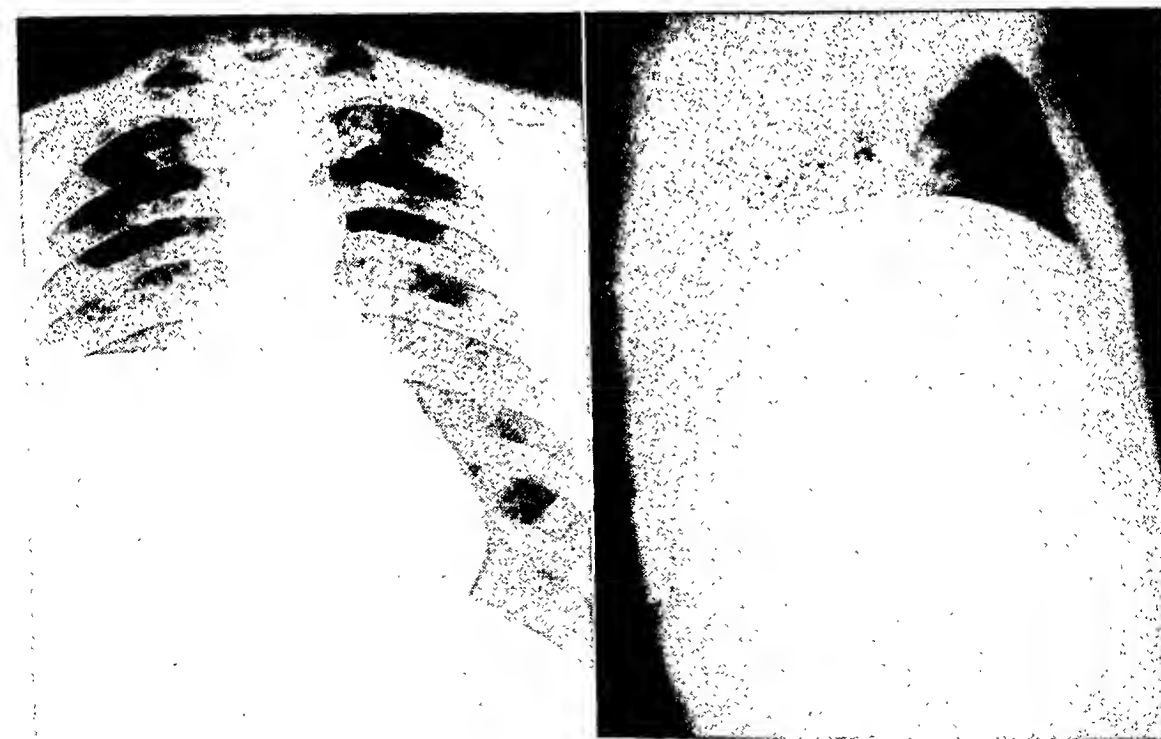
Hartung and Grossman report a case of trauma to the anterior chest wall resulting in a chest wall hernia. During quiet respiration no abnormality was observed roentgenographically. During the Valsalva act, however, a localized area of translucency was seen above the right side of the diaphragm in the seventh intercostal space anteriorly near the lateral portion of the chest wall. In the oblique position this could be seen to protrude beyond the confines of the remainder of the lung.

Hemorrhage into the pleural cavity is a frequent sequel of trauma. Roentgenographically, blood in the pleural cavity cannot be differentiated from other fluid. Frequently air is also present, producing the characteristic fluid level. Infection may set in and there may ultimately be a mixture of blood and pus. An occasional late sequel to pleural hemorrhage may be calcification in the visceral pleura. At times the trauma may cause no hemorrhage, but infection may occur with resultant empyema. Adhesions may form and this may be encapsulated. Sometimes in the postero-anterior view en-





Figs. 2 and 3. Encapsulated fluid in the lower portion of the left side of the chest. The appearance in the postero-anterior view simulates pneumonic consolidation. The lateral view shows the sharply defined area of encapsulated fluid posteriorly.



Figs. 4 and 5. Case of W. W. Stab wound in right side of chest six weeks previously; general malaise since, with recent pain at site of old wound. The postero-anterior view gives the impression of a subdiaphragmatic lesion. The lateral view also suggests a subphrenic lesion or possibly a huge interlobar accumulation of fluid. The surgeon later made a partial resection of the eleventh rib posteriorly establishing drainage, considering that he was in the pleural cavity. A film made after recovery revealed very slight evidence of pleural thickening.

capsulated fluid may simulate pneumonic consolidation, while it will be clearly outlined in the lateral view (Figs. 2 and 3).

At times interlobar or encapsulated fluid may simulate a subphrenic accumulation of fluid.

W. W., white male, age 61 years, had been stabbed in the right side six weeks before. For the past six days especially he had experienced pain in this side, with soreness in the anterior part of the chest along the costal margin and swelling about the old wound area. Physical findings suggested fluid in the right side of the chest. The postero-anterior film (Fig. 4) revealed a homogeneous opacity in the lower portion extending up to the projection field of the fourth anterior interspace, there being a slightly convex superior periphery. A subdiaphragmatic abscess was suggested by this view. The lateral view (Fig. 5) also revealed a convex superior periphery, which was compatible with such a lesion, but the visibility of the lower dorsal vertebral bodies tended to point against it. There was some suggestion that the shadow was fusiform, and a huge interlobar accumulation of fluid was considered as an alternative. Thick pus began to drain spontaneously through an area in the lower portion of the thorax posteriorly. Near this site a partial resection of the eleventh rib posteriorly was done and drainage established. The surgeon considered that the drain was in the pleural cavity. If such was the case, it is conceivable that the fluid may have been interlobar or encapsulated between the lower lobe and diaphragm. The possibility that it was subdiaphragmatic must still be considered, and the relative absence of pleural thickening on a subsequent film after recovery suggested this. A pneumoperitoneum would have been of value in this case to differentiate a supradiaphragmatic lesion from a subphrenic abscess.

Hemorrhage into the lung parenchyma occasionally occurs and may have the appearance of pneumonia, tuberculosis, or other infectious process. Occasionally atelectasis may result from consequent occlusion of bronchi or bronchioles. The mottled appearance of intrapulmonary blood will, as a rule, differentiate it from pleural fluid. Post-traumatic pneumonia can usually be readily ruled out if the film is taken immediately after the trauma. An opacity appearing in the pulmonary area after the lapse of a few days would be more apt to be pneumonia. Expectoration of bright red blood may aid in the differentiation, as well as the physical and clinical

findings. The disappearance of the findings after a few days aids in ruling out a chronic infection.

In some reported cases of blast injury without apparent external trauma pulmonary hemorrhage has been present, and in some cases hemorrhage between the parietal pleura and the chest wall. In other cases, pneumothorax, atelectatic areas, or consolidation was observed, with the characteristic roentgen findings. Bronchopneumonia was a frequent sequel.

Prowse reported a case in which an airplane made a nose-dive into the ground, pinning the pilot upside down, with a resultant depressed fracture of the manubrium and compression fracture of the fourth dorsal vertebra. The film revealed a homogeneous opacity in both upper lobes with high translucency of the lower zones. This was interpreted as due to acute pulmonary hyperemia and edema of the upper lobes with emphysema of the lower.

A number of cases have been reported by Jones and Vinson, and others, of rupture of a main bronchus due to external injury, often with a compression of the thorax. This condition is usually so rapidly fatal that films can seldom be taken. A few cases of recovery have been reported, however, with films taken after a long interval. The roentgenogram reveals an opacity throughout the entire side of the involved bronchus with displacement of the heart and trachea to the side of the opacity, the findings being due to a massive atelectasis.

The mediastinal structures may be involved by trauma. Severe damage to the large vessels ordinarily results in almost immediate death. Occasionally, however, a patient with hemorrhage into the mediastinum may survive, in which case it is widened, showing straight vertical borders. In the presence of a dissecting aneurysm, the widening is more localized.

A blow over the precordium or a penetrating wound may give rise to hemorrhage into the pericardium, with the usual findings of pericardial fluid. If bleeding con-



Fig. 6. Case of M. A. Trauma of unknown etiology. The film reveals fractured ribs, extensive subcutaneous emphysema, and a small amount of air in the left side of the mediastinum.

tinues, there may be a tamponading of the heart with resultant cessation of the beat. Fluoroscopy is necessary for study of such cases, the findings being those of pericardial fluid with a rapidly enlarging pericardial shadow, with decreasing impulses if bleeding continues. Repeated observations may aid.

Air is occasionally found in the pericardial sac and is demonstrated on the film by a slight clear area of separation between the pericardium and cardiac outline. A stab wound causing communication between the pericardial sac and the lung may cause air to be drawn in from the lung during the combination of cardiac systole and the inspiratory phase, or it may be drawn in directly from without.

M. A., white male, age 32 years, entered the hospital in coma, with numerous lacerations. His breath had an alcoholic odor and he was unable to give a history when consciousness returned. X-ray examination revealed a fracture of the 2d to the 6th right ribs, inclusive, in the axillary region, with extensive subcutaneous emphysema and evidence of a small amount of air in the left side of the mediastinum (Fig. 6). There was also a fracture of the pelvic bones. The chief thoracic complaint was pain in the right side of the chest, which persisted for over a month. Recovery ensued after prolonged hospitalization.

A white male, J. J., age 42 years, entered the hospital with a stab wound in the chest. He was

pallid, cold, and clammy. The hemoglobin was 50 per cent, and the red cell count 3,580,000. A stab wound, four inches in length, was present in the left sternal line at about the level of the fourth to the sixth ribs. The tones were distant. Fluoroscopy and roentgenograms (Figs. 7 and 8) revealed air and fluid in the pericardial sac with no visible cardiac pulsation. Dr. Wm. Hendricks operated



Figs. 7 and 8. Case of J. J. History of stab wound with air in the pericardial sac. In the lower film, taken with the patient supine, using bilateral penetration, a fluid level was demonstrable in the pericardial sac. At operation a stab wound was found in the left ventricle.

and found a stab wound in the left ventricle 18-23 mm. in length. This was repaired. The patient recovered.

L. G., white female, age 18 years, entered the hospital, having been stabbed in the chest by her husband. She was in profound shock. The blood



Fig. 9. Case of L. G. History of stab wound in the chest. Air is shown in the pericardial sac and a trace in the left pleural cavity. The elevation of the left dome of the diaphragm is presumably due to a subphrenic hematoma.

pressure was 80/60; hemoglobin was 57 per cent; red cell count 3,080,000. There was mild dyspnea. A penetrating wound at the level of the seventh intercostal space to the left of the xyphoid was demonstrated. Fluoroscopic and film study (Fig. 9) revealed a small amount of air and fluid in the pericardial sac with a 10 per cent pneumothorax on the left side. A fluid level was noted posteriorly. The left dome of the diaphragm was elevated and limited in motility, presumably due to a subphrenic hematoma. The chest findings diminished rapidly.

C. M., colored male, age 54 years, entered the hospital, a stab wound of the chest having occurred two hours previously. He noticed a sucking sound every time he breathed. Some pain was present. Examination revealed a gaping stab wound in the anterior chest wall. X-ray examination showed a small amount of air in the pericardial sac. There was a small area of homogeneous opacity in the base of the left side of the chest, possibly due to pleural fluid. Above this was some mottled opacity, which may have been due to a small amount of pulmonary hemorrhage, although this was not confirmed by hemoptysis. Six hundred cubic centimeters of blood were aspirated from the pleural cavity by Dr. Jerome Head, and the patient made an uneventful recovery.

Foreign bodies in the heart muscle or chambers are occasionally seen. Recently

one was observed fluoroscopically in our department. A bullet in the projection field of the cardiac shadow moved with the cardiac impulses, presumably being lodged in the heart muscle. This was an incidental finding, the trauma having occurred years previously. Ordinarily such a metallic foreign body, unless very minute, can be readily detected on the routine chest film, but sometimes it may be almost obscured, in which case a higher penetration will reveal it. Foreign bodies containing elements of a low atomic weight may not be so readily demonstrable. An illustration of this is given in the following case (previously reported by B. Neiman and J. F. Fitzgerald: *Am. J. Surg.* 42: 401-405, November 1938.)

E. S., white female, age 27 years, jumped eight feet through a window during a fire, striking the forehead and chest, with resulting lacerations. These were sutured. Nine months later the patient entered the hospital, having had ill health since the accident. She complained of vague pains in the right shoulder, with weakness, tendency to fainting, and pressure sensation over the heart.

The examination revealed râles in the chest with pericardial fluid. A volume of 30 c.c. of sero-sanguineous fluid was removed. The patient was pregnant and cardiac decompensation set in. Roentgen examination revealed increase of the cardiac borders compatible with pericardial effusion. The patient was delivered of a five-months fetus, stillborn, and died sixteen months after the accident.

*Autopsy* by Dr. Benjamin Neiman revealed within the heart a piece of glass 70 × 17-25 mm., and 2 mm. thick, having six sharp corners (Fig. 10). This was in the ostium of the tricuspid valve, extending into the right auricle and ventricle. There was an irregular scarring of the myocardium of the right ventricle. Old and recent mural thrombi were present in the right auricle and ventricle. There were multiple traumatic tears of the cusps of the tricuspid valve and pulmonary leaflets. A fibrous obliteration of the pericardial sac was also present, with a bilateral hydrothorax.

Here was a case where a large foreign body did not show on the film. That it could have been demonstrated if higher penetration had been used was shown by the fact that it was seen on the roentgenogram of the extirpated heart (Fig. 11).

Localization of a foreign body in the



Figs. 10 and 11. Case of E. S. Laceration of chest sixteen months previously. The drawing shows a piece of glass in the ostium of the tricuspid valve, extending into the right auricle and ventricle. The roentgenogram, made after autopsy, shows the glass within the heart, though it was not demonstrated on a film made during life, probably because of inadequate penetration.

thoracic cage may be needed: first, to determine whether its location demands removal; second, to direct the surgeon in the incision if removal is required; third, to outline the path traversed by the missile. The entrance wound may be in the abdomen or in another portion of the body, with the bullet lodging in the thorax. The absence of the projectile may also be of great importance, especially if there is an entrance wound in the thorax and no wound of exit. In such a case,



Fig. 12. History of automobile accident sixteen years previously, with severe trauma to the left side of the thorax. The film shows evidence of the old left rib fractures, with intestinal loops containing air in the projection field of the lower portion of the left side of the chest. The heart is displaced to the right. Differentiation must be made between an anterior herniation through the diaphragm and an eventration. A lateral view would be of aid, as would possibly pneumoperitoneum.

the abdomen and other tissues may be considered as possible resting sites. Subphrenic air may be found if a hollow viscus has been perforated. A partially spent bullet may occasionally be guided by a rib or other osseous structure in its course.

M. M., white male, age 14 years, was shot in the left axillary border three hours previously. His general condition was good. The bullet was palpable under the skin in the left side of the thorax posteriorly at the level of the 6th rib. The film revealed the bullet at this site and numerous minute metallic fragments adjacent thereto. A fracture of the fourth and fifth ribs posteriorly was observed, and a clouding of the mid portion of the left side of the chest. No pneumothorax was demonstrated and hence the bullet probably did not traverse the lung. The clouding may be explained on the basis of hemorrhage into the soft tissues of the chest wall. The course, with no occurrence of hemoptysis, also appeared to confirm absence of pulmonary involvement.

Penetration of the diaphragm may result in subdiaphragmatic hematoma and subsequent abscess. The characteristic findings of subphrenic fluid with raised and immobile diaphragmatic dome are present.

Occasionally, however, as previously mentioned, encapsulated fluid above the diaphragm may confuse. In the posterior-anterior view, a lobar pneumonia may rarely simulate. Everett and Wood reported a case where a bomb fragment entered the chest and penetrated the liver, tearing the bile passages, with a resultant subdiaphragmatic extravasation of bile.

Trauma to the diaphragm may result in herniation. If the hernia is on the left side, the characteristic appearance of the loops of bowel in the chest will often be distinctive, but at times the picture may

resemble cystic degeneration or multiple abscesses. A barium meal will serve for differentiation. At times the hernia may be confused with eventration of the diaphragm. The localization of the bulge in the lateral view will often aid. A left-sided eventration displaces the heart to the right, while a posterior hernia will not. If the hernia is located anteriorly, however, such a displacement will occur (Fig. 12). Pneumoperitoneum may at times be of value for differentiation.

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# Back Injuries: Introduction<sup>1</sup>

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LOW BACK PAIN is with us always. It was just as prevalent thirty-five years ago as it is today, and if this writer's experience went back one hundred years he probably would have found it just as prevalent then, although the busy pioneer had little time to think of his back. There is no field in medicine or surgery where changing styles in treatment have been so numerous as in this condition of low back pain.

With the advent of more powerful and faster transportation, stupendous lawsuits became the vogue and "railway spine" was the most frequent diagnosis assigned to low back pain. With the coming of the industrial age, especially when employees' compensation laws became an economic factor, our diagnostic nomenclature for low back pain increased amazingly, ranging from the old "sacroiliac sprain" to the present "herniated disk."

New and ever newer methods of treatment, often complicated and often surgical in approach, have been evolved to meet these changing styles in diagnosis. In many instances worthwhile advances in surgery have resulted, with great relief to certain persons with definite organic lesions. But to weed out those who need these more complicated or radical surgical procedures is the greatest problem confronting surgeons today. We must not lose sight of the fact that the same types of low back pain were prevalent among our fathers, grandfathers, and great-grandfathers, who, in spite of this and deprived of the benefits of modern surgery, survived and built a great country at the expense of more and longer hard, back-splitting labor than our present generation ever dreamed of performing. One great surgeon has

written: "Ruptured intervertebral disks . . . are, in fact, among the most frequent lesions treated surgically." We doubt this statement, and yet it shows the great tendency to surgical attack on low back pain. We should pause and ask ourselves the question: "Has our surgical enthusiasm made the human race more back-conscious than it was in the earlier generations?"

I repeat what I have written before: when indicated by such definite neurological findings that the diagnosis cannot be mistaken, the removal of cord tumors, osteomas, or protruding disks is a gift from God. But to approach all low back pains with operation uppermost in mind is to overlook the psychogenic, the postural, the muscle imbalance, and the numerous constitutional causes that are the predominant factors in the average run of painful low back cases. For these, operations on the spine or cord are never indicated. Even if a ruptured protruding disk is found and removed—a disk which, from the history in many cases, must have protruded for years—this does not always rule out the existence of the above conditions and does not necessarily mean that the patient henceforth will be free of low back pain.

There was a time when the removal of all foci of infection seemed to offer the hope of eradicating low back pain from suffering humanity. There is many a toothless person today who still has his low back pain. There were a few where the sacrifice of the teeth gave permanent relief. The removal of one or more halves or complete laminae of the lower vertebrae is a more difficult and more dangerous procedure than the pulling of teeth. The implication is evident. It must be reiterated that this is not a condemnation of laminectomy and the removal of a ruptured intervertebral disk when and if it is

<sup>1</sup> Presented, as part of the Symposium on Injuries of the Head, Chest, and Back, before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.



definitely indicated. On the other hand, to consider it, or ever to make it, the commonest of all surgical procedures is to place one of the greatest advances in surgery in the toothless category.

Presented with a patient suffering from low back pain, the responsibility of the surgeon becomes exceedingly great. When there has been a severe trauma with direct injury to the back, and when the roentgenological examination shows a definite compression fracture or a dislocated vertebra, his diagnostic problem is easily solved and logical treatment can follow. But when the patient states that a sudden twist, a jerk, or the lifting of a heavy object caused the pain, and when the surgeon accepts this etiological factor and begins to treat the case without a thorough complete examination, he is shirking responsibility. Too often the mild alleged etiological factor is only an incident, while the true cause may be hidden in some constitutional or pathological condition far removed, in another part of the body. This must be sought and found when the patient first presents himself if the true diagnosis and the proper management of the case are to be logically established.

The x-ray examination of the patient's back is always indicated, but too frequently we depend solely upon the roentgenologist for our diagnosis. If the least anomaly is present in the back, too many of us jump to the conclusion that this explains the low back pain, and if there is an alleged injury we accept it as the cause for the anomaly or more often assume that the injury has aggravated an existing condition. If the x-ray is absolutely negative, then the conclusion is too readily made that "torn muscles" or "sacroiliac sprain" or some other anatomical disturbance is the cause of the pain, latterly a herniated disk. Such diagnoses confirm the idea of injury and, if the patient is employed, he immediately becomes a "compensation case."

The roentgenologist, presented with such a case and told by the surgeon that the patient has an injured back, often fixes

the idea of localized trouble by describing in great detail or by merely mentioning such conditions as "slight thickening of the sacroiliac joint," "osteo-arthritis," "impinging transverse process of the fifth lumbar," "nuclear changes," "spondylolisthesis," "acute lumbosacral angle," or similar changes. As surgeons, have we made the roentgenologist feel responsible for finding some explanation for our theory that the trouble is localized in the spine? As surgeons, are we too ready to accept the roentgenologist's description of some of these spinal anomalies as the explanation of the trouble?

Roentgenologists might well ask the question: "Have you searched the entire body for a logical explanation of the low back pain before turning to the x-ray for a diagnosis?"

There are so many anatomical and constitutional causes for low back pain that the surgeon who accepts the patient's statement of alleged trauma, or who centers his examination on the low back only, or who depends solely upon the x-ray for his diagnosis, or who, without complete examination, starts physical therapy treatments (usually short-wave), or "shots," or back manipulations, or a back brace, cast, or sacroiliac belt, or turns to operative treatment, is bound to find himself in error in a certain number of these cases.

Every specialty in medicine has its share of low back pain. To jump to the conclusion that some pelvic condition, as a displaced uterus, or some genitourinary condition, usually a floating kidney, or some orthopedic condition, too often a sacroiliac sprain or a spondylolisthesis, or some neurosurgical condition, frequently a herniated disk, is responsible, or that the condition is purely one for physical therapy, likewise may lead to error.

I reiterate, there is no other field in medicine or surgery that has been the seat of so many changing styles, both in diagnosis and treatment, as has this condition of low back pain. There are so many constitutional and anatomical causes, so many psychogenic factors, that can be respons-

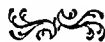
ible for low back pain that it is almost impossible to give one definite diagnostic name to the existing condition. Patients like the doctor who can give a definite straight-from-the-shoulder diagnosis. Thus, the osteopath, with his emphatic diagnosis of a displaced vertebra, meets their approbation. But in low back pain the conscientious doctor must delve into the psychogenic factors that may be back of it: the fatigue reactions from monotony of employment or from the high-tension under which executives or social celebrities work—the type that often suffers from spastic bowel; flat back and other anatomical poor-postural reactions, all of which are accompanied by muscle imbalance, which alone can give the severest of low back pain; and finally, he must find and explain certain constitutional conditions which may aggravate the pain. Confronted with one or all of these conditions, it is impossible to give the patient a single diagnostic entity to hang his hat on or win his confidence.

In lieu of a diagnostic entity, the patient likes the doctor who can offer a single straightforward therapeutic measure to be followed. Thus, "you need a sacro-iliac belt," or "a back brace," or "a cast,"

or "an operation," wins the patient's confidence and, once this is won, he will continue the treatment indefinitely to prove that it was just what his back needed. It takes a great deal of time and great salesmanship on the part of the surgeon to explain the intricate factors behind low back pain, to substitute reason and common sense for a diagnostic entity, and to persuade the patient to change his habits of living, to squat and lift correctly, to go through exercises that will correct his postural defects and restore a normal muscle balance in his back, and finally to show him, as is so often the case, that the trouble lies within himself and not in an alleged injury. If the surgeon will look at the patient as a whole and not concentrate too much on the low back, he will rehabilitate a great many of these patients without too complicated or too prolonged treatment.

In these days of needed man power, this is the essence of treatment. In the major back injuries we have solved the problem exceedingly well. In the rehabilitation of the great group of sufferers from low back pain we have lagged behind.

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# Anatomical and Physiological Considerations Prerequisite to Diagnosis of Back Trauma<sup>1</sup>

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THE ANATOMY OF low back pain following injury involves practically the structure of the entire living human body. For the purposes of this paper, the anatomy and physiology of the back will be considered from a broad and not a detailed descriptive point of view.

The variable character of low back pain, its multiplicity of causes, the complexity of the anatomic structures involved, and the difficulties in its treatment render this affection one of the most baffling problems that confront the physician. The condition has important industrial and economic aspects. Many persons habitually assume, at work or otherwise, positions seriously at fault mechanically, and sooner or later under the stress and strain the body tissues rebel and backache results, with or without trauma. Industry suffers a severe drain on its man power from this type of affection, since slight traumata may throw on the disabled list for very long periods those whose bodies have been repeatedly insulted by postural errors and the consequent mechanical strain. Exact anatomical knowledge is necessary for accurate diagnosis.

In the past, the anatomy of the back has been neglected too frequently by medical students. Since charlatans are most liable to promise relief in fields where medical and anatomic knowledge is deficient, it becomes an obligation on each practitioner to possess knowledge of the anatomy underlying backache following injury.

## ANATOMY OF THE HUMAN SPINE

The human spinal column is the central axis of the skeleton and is situated in the

median line at the posterior aspect of the trunk. It is normally composed of thirty-three segments or vertebrae, twenty-four of which are true or movable and nine false or fixed vertebrae. Of the true vertebrae, the first seven are called cervical, the succeeding twelve, thoracic or dorsal; the remaining five, lumbar. Of the false vertebrae, the first five form one mass, called the sacrum, and at the terminal part of the column are three to five fused segments forming the coccyx.

The vertebral column functions as a pillar of support for the trunk and a case for protection of the spinal cord, nerve roots, and meninges. Cephalad it supports the skull; laterally, it gives attachments to the ribs, through which in part it receives the weight of the upper limbs; caudad it is supported by the hip bones, by which the weight of the trunk is transmitted to the lower limbs. The structure of the whole column accords with the necessities of these functions, and thus the vertebrae of which it is composed show their individual agreement with the general arrangement of the whole: they are modified in details according to their position, but they are all built on the same general principle.

This principle may be demonstrated, briefly, by a vertebra taken from the center of the column and used as an illustration of the positions of the chief parts of a "typical" vertebra. In front a strong body carries and transmits weight. It is the more fixed part of the column and to its dorsal aspect is attached the spinal cord. The attachment of the spinal cord to the most stable bodies prevents its overstretching in flexion of the column. The neural arch behind the bodies encloses the spinal cord: in conformity with this we find the strong pads of intervertebral disks placed be-

<sup>1</sup> Presented, as part of the Symposium on Injuries of the Head, Chest, and Back, before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill. Nov. 30-Dec. 4, 1942.

tween the bodies of contiguous vertebrae, whereas the arches are connected by ligaments and tend to overlap one another. The arch is relatively more movable than the bodies. In the articulated column the successive arches and ligaments, with the dorsal aspect of the bodies, enclose a spinal canal for the cord and meninges (pachymeninges and leptomeninges), and the portion of the canal that is enclosed in the neural arch of each separate segment is the spinal foramen of that vertebra. The neural arch has spinous, articular, transverse processes, as well as laminae and pedicles. No details as to these structures are necessary in this paper.

The length of the spinal column varies in different skeletons. The average is about 70 cm. in the male and about 2.5 cm. less in the female. It constitutes about 45 per cent of the body length. To the entire length of the column the cervical region contributes about one-sixth, the thoracic about one-third, the lumbar about one-fourth, and the sacrococcygeal portion the remaining one-sixth. About one-fourth of the length of the presacral spine is made up of the intervertebral disks. The pathology of these disks is becoming more important as one cause of low back pain.

The striking characteristic of the complete articulated column, when viewed as a whole, is the presence of "curves." There are two sets of curves: the primary or accommodation curves and the secondary or compensation curves. There are four of these in the sagittal plane or profile view, convex forward in the cervical and lumbar regions, concave forward or ventrad in the dorsal and sacral zones. The dorsal curve is primary and may be looked on as the persisting curve of the embryonic axis. The sacral curve is also primary. These two primary curves are for the accommodation of the thoracic and pelvic viscera. The thoracic curve extends from the second to the twelfth dorsal vertebra, and the sacral curve coincides with the sacrum and the coccyx.

The secondary curves of compensation

are found in the cervical and lumbar regions and have their convexities directed ventrad. They are curves that compensate for the assumption of the upright posture and are developed due to changes in the intervertebral disks. The cervical curve appears in the infant with the development of ventral flexion of the head on the chest, at about the third postnatal month, and with the sitting posture at about the sixth postnatal month. The curve is never consolidated or fixed in the vertebral column. It is present in the upright but obliterated in the horizontal posture.

The lumbar curve, between the twelfth dorsal vertebra and promontory of the sacrum, appears between the ninth and twelfth postnatal month when the child begins to stand and attempts to walk. This curve becomes consolidated in adult life.

The most anterior part of the cervical convexity is the front of the body of the fourth cervical vertebra, and the curve ends below at about the second dorsal vertebra: the body of the seventh or eighth dorsal vertebra usually forms the point of greatest posterior projection in the dorsal curve, which ends below between the twelfth dorsal and first lumbar vertebrae.

The fifth curve is lateral and is a secondary, compensation curve. It is in most cases directed to the right and is found in the upper thoracic or dorsal region. Its convexity, usually to the right, is probably associated with the greater use of the right hand. It is modified by race and occupation. The common finding in the ventro-dorsal view, therefore, is a physiologic right lateral scoliosis.

The primary curves of accommodation have associated direct changes in the bodies of the dorsal and sacral regions, whereas the secondary or compensation curves have associated changes particularly in the disks. At about the third week of intra-uterine life the first primary curve appears with the snail-like coiling of the entire embryo. During this time the

vertebral column has a pronounced ventral flexion. The uncoiling of the embryo occurs between the third and sixth week of intra-uterine life. The movable or free portion of the vertebral column gradually becomes straighter and later acquires a second ventral curve. In the newborn child the true or free column forms a single gentle curve with a ventral concavity extending from the first cervical to the last lumbar vertebra, while the sacrum and coccyx are directed somewhat dorsad.

In the female the sacrum is turned dorsad to a greater extent than in the male. This causes a more prominent lumbosacral angle, but it is modified by the lumbar curve becoming more pronounced; thus in women the fourth lumbar vertebra is usually more prominent than in men. If an anomalous sixth lumbar vertebra is present, there is consequently a still greater tendency to spondylolisthesis, a forward gliding of the caudal surface of the fifth lumbar vertebra over the cephalic aspect of the first sacral vertebra.

The aortic impression consists of a variable flattening of the left side of the dorsal vertebrae from the fourth to the tenth segment.

From the ventral aspect the bodies of the vertebral column present a series of pyramids due to the successive increase and decrease in the size of the bodies. They become wider from the axis to the first dorsal vertebra, then decrease to the fourth dorsal vertebra. The apex of the first pyramid is directed upward, and that of the second is directed downward. Their bases are in opposition. The third pyramid extends from the fourth thoracic to the fifth lumbar vertebra, with its base caudad. The fourth pyramid includes the sacrum and coccyx, with the base cephalad and the apex caudad.

In the lateral view, the intervertebral foramina appear oval in shape. These foramina increase in size progressively, cephalocaudad, being smallest in diameter in the cervical and largest in the lumbar region. The spinous processes of the

second and seventh cervical, first thoracic, and all the lumbar vertebrae are most prominent.

From the dorsal aspect the line of the spines shows frequent irregularities without any deviation in the line of the weight-bearing bodies. On each side of the line of the spines the vertebral groove runs down the length of the column, floored by the laminae and backs of the articular and transverse processes. It is occupied by the deep and superficial layers of the post-vertebral muscles.

#### BONY ANOMALIES OF THE LOW BACK

Many persons with anomalies of the spine are symptom-free, but their backs are less stable and more prone to stressing strain in injury. These anomalies may be classified as follows:

1. Elongation of the transverse process of the fifth lumbar vertebra, found in 25 per cent of cases of low back pain. This process impinges on the ilium and the friction forms a painful bursa.
2. Sacralization of the fifth lumbar vertebra. One or both transverse processes of the fifth lumbar may be involved. This anomaly is found in 3.5 per cent of normal persons, and in 50 per cent of these low back pain is a common experience.
3. Defect of the neural arch (*spina bifida occulta*). This is found in 5 per cent of the spines examined by x-ray. The spine is weak and prone to injury.
4. Variations of spinous processes (the kissing spinous processes, which come in contact with one another, forming a bursa which is painful as a result of the constant irritation by friction).
5. Variations of the lumbosacral angle. There may be abnormal lumbar lordosis which leads to sprain because the sacrum is horizontal.
6. Variation of the articular facets.
7. Spondylolisthesis.
8. Constitutional variations. The long thin individual is likely to suffer sacroiliac sprain, while a short heavy person is likely to experience lumbosacral sprain.

## PHYSIOLOGY OF THE SPINE

The curves of the vertebral column serve the following purposes: (1) they contribute to the wonderful strength of the spine, sixteen times that of a straight one, since its curves are alternating; (2) they convert the spine into an elastic structure and thus afford a springy pillar upon which the head shall rest, minimizing the danger of severe jarring of the brain; (3) they are so arranged as to favor the lodgment of organs, since the cavity of the chest is greatly enlarged thereby, and the weight of the organs is still kept within the line of the center of gravity, a fact to be considered in the arrangement of muscles, as less power is required to preserve the proper balance; (4) they are so gradual as to prevent the possibility of compression of the spinal cord, which might occur were there any abrupt angles to the canal; (5) the curves of the cervical and dorsal regions add greatly to the beauty of outline of the body, while the former facilitates the movements of the neck.

The curves of the vertebral column are due, in great measure, to the variations in thickness of the intervertebral fibrocartilages, which constitute one-quarter of the length of the movable spine, but partly also to the relative thickness of the bodies of the vertebrae of the different regions, and to the tension exerted by the ligamenta subflava, which join together the laminae of the different vertebrae.

The spinal column is capable of four types of movement, *viz.*, flexion, extension, lateral, and torsion. The first two are freest in the neck, least free in the dorsal region, and less free in the loins than in the neck. This is largely due to the fact that the spines of the dorsal vertebrae overlap each other, particularly from the fourth to the eighth, and that the articular processes of the dorsal vertebrae are nearly perpendicular, so that movement is prevented; while in the cervical region the articular processes are oblique, the intervertebral disks thick, and the spinous

processes of the third, fourth, and fifth vertebrae are purposely made short and horizontal. The lumbar vertebrae have also thick intervertebral disks, which allow of movement between their spinous processes; and the articular processes are so placed as to allow of a limited movement. Flexion and extension of the spine are freest between the third and sixth cervical vertebrae, between the eleventh dorsal and second lumbar vertebrae, and again between the last lumbar vertebra and the sacrum. In cases of tetanus and in those feats of the aerobist where the body is made to rest upon the head and heels alone, this point is admirably shown. The lateral movements of the spine are very free in the neck, so as to allow of an easy carriage of the head, and in the loins so as to permit of movement of the trunk. The movement of rotation of the spine is confined almost exclusively to the lumbar region, and it is this power of movement that enables the head to be rotated beyond the ability of movement of the atlas upon the axis, through a participation of the trunk. Holden suggests an admirable way to demonstrate this point: "Sit upright, with your head and shoulders well applied to the back of the chair; the head and neck can be rotated to the extent of 70°. Lean forward, so as to let the lumbar vertebra come into play; you can then turn your head and neck 30° more."

The intervertebral disks are soft and of a pulpy consistence in the central portion but firm at the edges. They thus tend to form a ball-and-socket joint which permits of a certain amount of movement in every direction between the vertebrae which they separate. By the weight of the body they are compressed, so that in the evening the height of a person is often diminished some fraction of an inch from the measurement taken after a night's repose. A habit of leaning toward one side may cause a permanent deformity by destroying the elasticity of these cartilages. Thus, a distortion of the spine may not always indicate disease.

Upon each side of the spines of the

vertebrae may be perceived a deep groove for the strong muscles of the back. If we look at the spinal column from the front, we can perceive that the transverse processes of the atlas are very long so that the muscles which rotate the head can gain additional leverage. An enlargement of the column can be detected at the lower part of the cervical region, so as to form an expanded base for the neck, and a diminution in the width of the column can be detected in the dorsal region, in order to afford more room for the lungs. A slight lateral curvature in the dorsal region may often be perceived, which is attributed by some to the excessive use of the right arm, since the concavity is usually toward the left side. This point should be remembered as a frequent and natural deformity when diagnosing a lateral curvature as the result of disease.

Along the entire length of the spinal column on its posterior aspect the spinous processes form a prominent bony ridge, which may be felt through the skin of the back even in the fattest people, and which is occasionally prominent throughout life. It will be noticed that the spine cannot be felt in the cervical as distinctly as in the dorsal and lumbar regions, for the following reasons: (1) on account of the curve; (2) on account of the attachment of an elastic ligament (the ligamentum nuchae) which extends from the head to the last cervical vertebrae and assists the muscles in supporting the head at a right angle to the spine; (3) from the fact that the spines of the third, fourth, and fifth cervical vertebrae are shorter than the rest so as to admit of free extension of the neck; (4) on account of the muscles which tend to render the long spine of the axis less prominent than it would otherwise be. In a muscular subject, the spines of the vertebrae of the dorsal and lumbar regions, instead of being prominent as they are in the skeleton, lie in a median depression or groove, which extends the entire length of the back and is caused by the prominence of the erector spinae muscles upon either side of the spines.

The spinal canal which is enclosed by the vertebrae extends throughout the entire length of the spinal column and contains the spinal cord and the lumbar, sacral, and coccygeal nerves, after the spinal cord has terminated in the cauda equina. The vertebrae so overlap each other, posteriorly and at the sides, that it would be extremely difficult for any cutting instrument to injure the spinal cord, except between the occiput and the arch of the atlas, where animals are usually "pithed," and in the lumbar region, where a cutting instrument might possibly injure the lumbar or sacral nerves. The spinal canal is larger in the neck and the lumbar region than in the dorsal, which fact is explained on two grounds: (1) because there are two enlargements present on the spinal cord (where the large nerves of the upper and lower extremities arise), which demand increased space; (2) because the dorsal region does not admit of much motion and therefore the spinal cord requires less room to insure its safety from pressure than in the neck or lumbar region, where the movements of the spinal column are more extensive.

The vertebrae are so interlocked, by their spinous and articular processes, as to render the danger of dislocation of any bone extremely slight; in fact, such an accident would be impossible in the dorsal and lumbar regions without a fracture of the processes having first occurred. In the cervical region, however, such cases have been reported, and specimens of the dislocation are shown in some of the large collections of osteological curiosities. Sudden and forcible rotation of the neck may be followed by such dislocation.

The excessive length of the transverse processes of the atlas affords one of the many examples of the provision to increase the leverage of muscles and thus to add to their power, inasmuch as the inferior oblique muscles of the neck are enabled to rotate the head with greater ease than if the transverse processes were of the same length as those of the other cervical vertebrae.



# The Differential Diagnosis of Traumatic Lesions of the Spine<sup>1</sup>

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**M**Y PART IN THIS symposium is to discuss certain aspects of the roentgenology of the spine. This paper will not consider fractures or dislocations but rather conditions of the spine not due to an individual trauma, which, nevertheless,

may be mistaken for the results of an injury. It occurs in the absence of trauma. Because of the torticollis present, it may be difficult to get satisfactory roentgenograms. The dislocation is a rotatory one and may be hard to demonstrate by the usual open-mouth position



Fig. 1. Non-traumatic dislocation of upper cervical vertebrae. Note the anterior displacement of the anterior arch of the atlas.

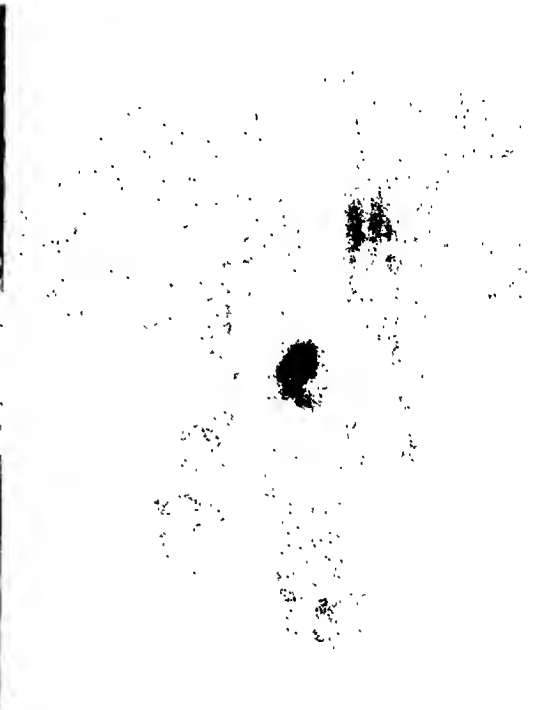


Fig. 2. Lateral view. Note the dislocation of the masses of the atlas and axis.

may be mistaken for the results of an injury.

Non-traumatic dislocation at the atlanto-axial joint is a definite entity (4). This condition occurs in young people and usually accompanies an infection in the throat and in the cervical lymph nodes. It may be present in the course of a rheu-

matoid fever. It occurs in the absence of trauma. Because of the torticollis present, it may be difficult to get satisfactory roentgenograms. The dislocation is a rotatory one and may be hard to demonstrate by the usual open-mouth position for this reason. It is of considerable importance to consider this condition in order to show that there is a definite contact between the posterior surface of the atlas and the dens of the odontoid process (Figs. 1 and 2). In the roentgenogram this contact is clearly visible (Figs. 1 and 2).

Persons who have a dislocation of the neck may e

<sup>1</sup> From the Departments of Radiology of Columbia Hospital and Marquette University. Presented, as part of the Symposium on Injuries of the Head, Chest, and Back, before the Radiological Society of North America, at the Twenty-eighth Annual Meeting, Chicago, Ill., Nov. 30-Dec. 4, 1942.

area and also down one or both arms, which they are prone to ascribe to the accident. Hypertrophic changes are common about the anterior aspects of the fifth and sixth vertebral bodies, but in patients with post-traumatic neck pain, the posterior aspect of the vertebra should be examined for posteriorly projecting spurs. Oblique views of the cervical spine should always be taken in these cases if there is seen in the anteroposterior plate any considerable thickening and sclerosis of the upper corners of a cervical vertebral body (5). Sometimes these phenomena are pronounced and will explain many of the patient's symptoms, so that if they can be demonstrated soon after an accident, they must have been there before the accident and the most that can be claimed is an aggravation of a previously existing condition (Fig. 3).

In the dorsal area there are two conditions that call for consideration in the differential diagnosis between traumatic and non-traumatic conditions of the spine. One is the collapse of a vertebral body due to osteoporosis, the so-called senile kyphosis; the other is the result of disturbances in the epiphyses of a vertebral body.

Collapse of a vertebral body in osteoporosis may present some exceedingly difficult roentgenologic problems. We know that collapse can occur without the patient being aware of any specific trauma. Yet, in a person with poor bone density in the dorsal spine, a minimal injury, which would not affect a normal vertebra, may be sufficient to crush those of lessened strength. When confronted with a situation in which a person with an osteoporotic spine has been in an accident and shows a collapsed vertebral body roentgenographically, the radiologist cannot be dogmatic regarding the cause of the collapse. Because of the location and the appearance of the collapsed vertebra and its neighbors, he may feel sure that he is dealing with a solely osteoporotic lesion, unrelated to trauma, yet he cannot deny that a given trauma could have been the cause.



Fig. 3. Oblique cervical roentgenogram showing osteophytic projections into a nerve canal.

There are several disturbances in the epiphyses of the vertebral bodies, the end-results of which may be mistaken for the results of trauma. Osteochondritis of the secondary vertebral epiphyses, the so-called Scheuermann's disease, is a fairly common condition. The x-ray appearance of irregular wavy upper and lower vertebral body surfaces, with symmetrical wedging of the bodies, is characteristic and does not resemble the effects of fracture. The relation of this condition to trauma is not well understood, and its morbid anatomy has not been fully investigated, so that here, too, one cannot be dogmatic when discussing the role of trauma in a given case. It would seem, however, that the burden of proof rests on anyone who would claim that the condition is due to a given injury (6).

There is another type of epiphyseal involvement which, for the want of any better name, may be called a "localized epiphysitis." This occurs in the lower dorsal or upper lumbar region and involves the upper or lower anterior corner of the vertebral body as seen in the lateral view. One vertebra—or at the most two—is involved. The appearance may resemble

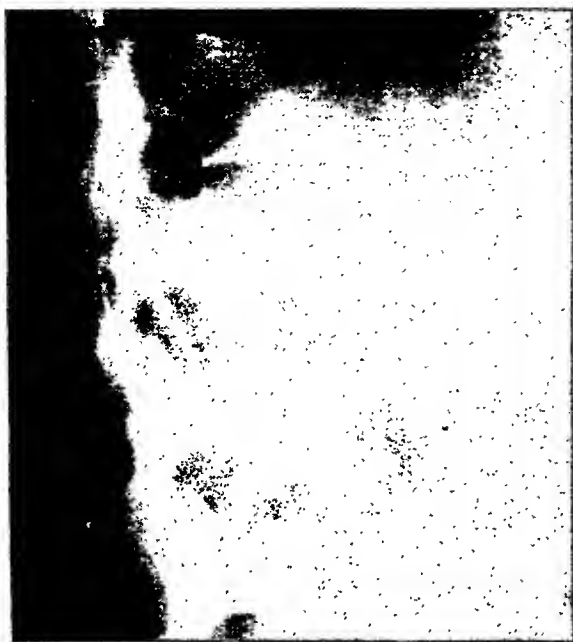


Fig. 4. Old "localized epiphysitis" of a lumbar vertebra six years after original roentgenograms.

osteocondritis elsewhere; there is an increased density, with perhaps fragmentation of the anterior portion of the epiphyseal ring, and the vertebral body of the epiphysis involved is beveled off more than usual (Fig. 4).

This condition which has just been discussed is of particular interest when considering the etiology of the final group of epiphyseal disorders, that is, the group showing a separation of bone at the anterior angles of the vertebral body. This condition has been discussed, particularly in the foreign literature, under the name of "persistent epiphyses." In these cases the roentgenograms reveal a defect in the upper anterior portion of the vertebral body. Above and slightly anterior to the defect is a triangular piece of bone, roughly of the same shape as the defect. At times an apparent cortex can be demonstrated about the periphery of the fragment. These findings have been interpreted in various ways. They have been called "persistent epiphyses"; they have been regarded as the result of a direct trauma (3), and, again, as a result of nuclear intrusions into the vertebral bone. That they are not true "persistent epiphyses"

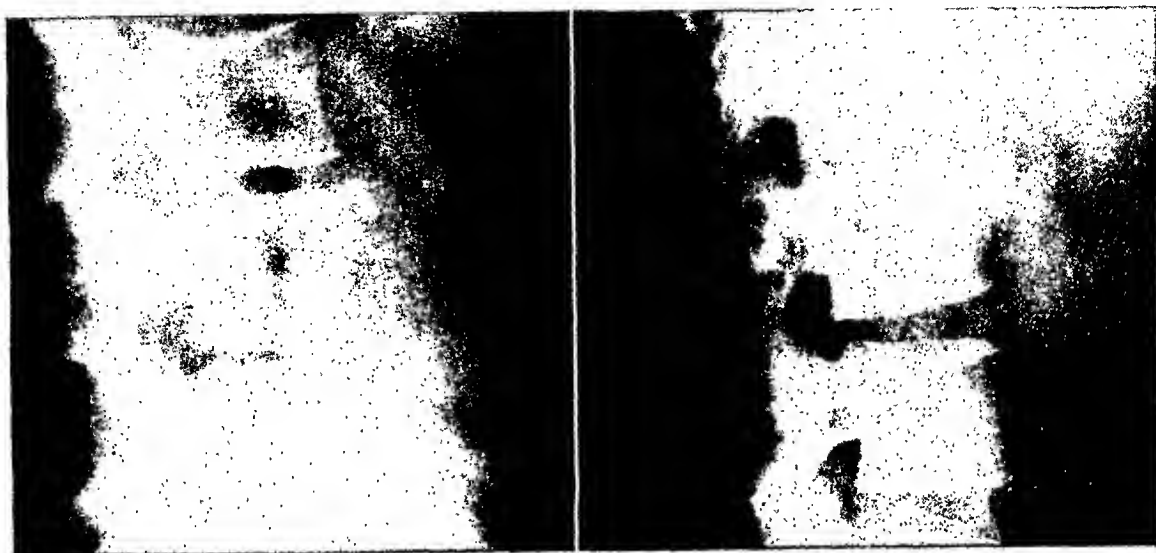
has been shown (1, 2), and Niedner makes a convincing case for their causation by a nuclear protrusion, like Schmorl's nodes located anteriorly in the vertebral body. This protrusion so weakens this part of the vertebral body that these corners may be pulled away by muscular or ligamentous action (2) (Figs. 5 and 6). Whatever be their origin, they should not be regarded as compression fractures. They are seen usually in men and are not necessarily associated with symptoms related to the back. They are not unusual, and the radiologist should be guarded in his statements concerning them.

The vicinity of the dorsolumbar junction is the commonest site for Schmorl's nodes. Theoretically, they should be due to trauma, but one can seldom identify an injury which could be the cause of a specific lesion.

The biconcave expansions of the intervertebral disks which one sees so often in the lumbar region should also be due to trauma, but here again it is difficult to assign any definite injury as the cause of the particular lesion demonstrated.

Kümmell's disease of the spine was a fertile topic of roentgenological argument some ten years ago. The premise that an injury to a vertebra will sometimes be followed by a latent period, after which the body will rarefy and collapse, does not seem to be established beyond doubt. It can at least be said that it is not a common phenomenon and that the radiologist had best avoid the use of the term "Kümmell's disease" unless he is very sure of his ground.

In the region of the lumbosacral junction, there is a host of congenital abnormalities with which the radiologist is familiar. These are not likely to be confused with the results of trauma, but there is one condition which has been considered to be of congenital origin that must be discussed, namely, separation at the pars interarticularis or isthmus. This phenomenon is best seen in the oblique view and may be overlooked if dependence is placed only on anteroposterior and lateral



Figures 5 and 6. So-called "persistent epiphyses": an incidental finding; no history of trauma.

projections. Separation at the isthmus is present in spondylolisthesis and is often present in the absence of any forward slipping of the body.

Is this gap of congenital or developmental origin or may it be due to a recent trauma? The defect does not look like the result of a recent localized trauma; the edges are too smooth; cortex can sometimes be demonstrated along the line of fissure; the gap is too wide, and the appearance is too uniform from one case to another. On the other hand, the gap is not in the line of any normal epiphyseal closure and it is not seen in the examination of embryonic spines, while it is present in something up to 5 per cent of adult spines, so that it is hard to explain on a congenital basis. In spite of several notable contributions (7-9), there does not seem to be any entirely adequate explanation of this phenomenon. Hitchcock (10) claims, on what appears to be good evidence, that the condition is produced by injury at birth or shortly afterward and that it is not likely to be due to trauma after the bones have developed.

A variety of names have been applied to this condition, such as pre-spondylolisthesis, spondyloschisis, and spondylolysis. These are apt to be confusing terms and it would seem best to refer to the lesion

simply as an isthmus defect. It is seen usually in the arch of the fifth lumbar vertebra, but lumbar vertebrae higher up may be involved. In adult life these lesions should not be considered as due to a distinct trauma unless incontrovertable grounds for that opinion exist.

Destructive processes of the vertebral bodies due to osteomyelitis or malignant neoplasms, either primary or secondary, will not be discussed. The differentiation from the effects of trauma in these cases is usually not difficult.

The relation of hypertrophic changes about the spine to alleged trauma may be a difficult problem. One may see marked hypertrophic changes in the spines of sedentary persons with no history of trauma, while such changes may be absent or slight in others who have had much minimal trauma. Following the fracture of a vertebral body, many hypertrophic changes may develop about the damaged vertebra. In other cases, however, there are none. There seems to be little correlation between the extent of the injury and the subsequent development of hypertrophic spurs. It would seem, therefore, that one must not be dogmatic in ascribing this or that hypertrophic change to this or that injury. It may have had nothing whatever to do with it.

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## CONCLUSIONS

The radiologist can identify a certain group of appearances, such as the usual fractures and dislocations and say that they are definitely due to a specific trauma. There are several conditions of obscure etiology which produce manifestations in roentgenograms of the spine which might be regarded as the results of a definite injury, but which are likely not. In this group the radiologist must be excessively careful; he must not be too dogmatic and he must take an entirely objective view.

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# Pseudotumor of Bone in Hemophilia<sup>1</sup>

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HEMOPHILIA IS A constitutional disease characterized by a delayed clotting time of the blood and a lifelong history of repeated prolonged hemorrhages. The disease is hereditary and its transmission depends upon a sex-linked recessive mendelian characteristic. Since hemophilia is dominant in the male and recessive in the female, women never suffer from the disease but transmit it to some of their male offspring.

The existence of the disease in early times is intimated, according to Quick (1), by certain passages in the *Talmud*. In *Tractat Jebamoth* is an account of four sisters who lived in Zipporah. The first three lost their sons when they were circumcised. Quick states that it is logical to assume that hemorrhage was responsible for death following this religious rite. Albucasis (2) in 1519 reported a condition resembling hemophilia. He stated that in a certain village there were men who, when wounded, suffered uncontrolled bleeding which resulted in death. Otto (3) in 1803 was the first to establish the fact that the disease was a distinct clinical entity.

Wright (4) in 1893 was the first to report specifically that the clotting time was prolonged in this disease. Alexander Schmidt (5), however, must be credited with the first attempt, in the same year, to determine experimentally the defect in coagulation which is responsible for hemophilia. Quick, Stanley-Brown, and Bancroft (6) concluded that there is a deficiency of thromboplastin in this disease. Sahli (7) in 1910 reported his studies showing that normal blood cells when added to hemophilic blood hastened coagulation. He did not determine which particular cell was responsible. In 1914 Fonio (8) proved

that the important cells which function abnormally in hemophilia are the platelets. His work was confirmed by Minot and Lee (9), who stated: "In hemophilia we have an hereditary defect in the blood platelets. This defect consists of a slow availability of the platelets for the purpose of coagulation." In a subsequent review of hemophilia, Fonio (10) concluded, on the basis of his or other workers' reports, that in hemophilia the platelets are abnormally resistant and therefore deliver the platelet clotting factor too slowly for normal coagulation. Quick states that the primary defect may be the lessened tendency of platelets to agglutinate and refers, also, to the work of Lee and Erickson (11), who reported that the disintegration rate of platelets is retarded in hemophiliacs and in menstruating women. He suggests the possibility that a sex factor exists which tends to keep the platelets labile and that this factor is depressed during menstruation and chronically deficient in hemophilia.

Hemorrhage in hemophilia may be external or internal. It may be the result of trauma or spontaneous. Common sites of bleeding are the various joints, of which the most frequently involved are those most commonly subjected to trauma, namely, the knee, elbow, ankle, hip, shoulder, and those of the hands and feet. Koenig (12) in 1892 first described the pathological sequence of events occurring in hemarthritides. His work has been reviewed by Prip Buus (13) and others. Shaw (14) was probably the first to describe, in 1897, the roentgen findings in a case of hemarthrosis due to hemophilia. Since his initial report the literature, both English and foreign, has become abundant on this subject. More recent roentgenographic studies have been made by Freund (15), Doub and Davidson (16),

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Fig. 1. The appearance of the left leg a few hours prior to amputation. Note the biopsy site and area of necrotic skin.

Reinecke and Wohlwill (17), Key (18), Thomas (19), Newcomer (20), Caffey and Schlesinger (21), and McDonald and Lozner (22).

Because of the fact that little has been written regarding bone lesions beyond the epiphyses in hemophilia, and because of the unusual findings in one case, it has been considered worthy of report.

#### CASE REPORT

P. W. (R-4691), a 13-year-old white boy and known hemophiliac, was readmitted to the medical service of the James Whiteomb Riley Hospital for Children on Jan. 7, 1939, complaining of a painful swelling over the anterior surface of the left leg below the knee and loss of appetite and weight of three weeks' duration.

**Family History:** The mother, living and well, had two great uncles who were supposed hemophiliacs. The father was living and well. The patient had a brother living with complaints similar to his own and two sisters living and well.

**Past History:** The patient's birth and development were normal. He had scarlet fever, pertussis, chickenpox, mumps, and poliomyelitis all prior to his first admission at the age of 7 years. He had always bruised easily and, with even the slightest injuries, hemorrhages occurred beneath and in the skin, disappearing very slowly. Since the age of three he had experienced stiffness of various joints of varying degree and on numerous occasions had been obliged to remain in bed for periods of several weeks because of painful, stiff, swollen joints.

**Hemophilic History:** 12-6-32: At the age of 7, the patient was admitted complaining of severe ab-

dominal pain and vomiting for 24 hours. Red blood cells 1,570,000. Platelets 210,000. Clot retraction time 3 1/2 hours. Coagulation time 6 minutes. Bleeding time 3 minutes. Diagnosis: Intramuscular hemorrhage in the abdominal wall due to hemophilia. Gradual improvement followed small blood transfusions and sensitization to sheep serum. The patient was discharged to the clinic for follow-up and periodic injections of sheep serum.

1-24-33 to 8-8-33: In this period the patient made eight return visits to the clinic for observation because of severe bleeding for a week following a cut finger and for numerous hemorrhages into the elbow, shoulder, knee, and ankle joints, the dorsum of the right hand, and the right great toe.

9-16-33: At the age of 8 the boy was readmitted because of a painful swelling of the knee and thigh. He received blood transfusions, ovarian extract, sheep serum, and physiotherapy and was discharged 12-7-33.

3-13-34: Readmission because of a cough and pronounced swelling of the soft tissues of the anterior portion of the neck from the mandible down over the chest to the level of the nipples. The skin over this area was dark blue in color. The swelling was checked following small blood transfusions and had disappeared by the time of discharge, 3-26-34.

11-6-34: Readmission, at the age of 9, because of a painful swelling of the left knee and numerous subcutaneous hemorrhages over the body, which occurred during sleep. These responded well to treatment and the patient was discharged 11-22-34.

3-26-35: Readmission because of a painful swelling of the left ankle, which occurred during sleep. Improvement following small transfusions; discharge 6-8-35.

8-27-35 to 3-24-36: During this period the patient was seen in the clinic five times because of painful swellings of the right elbow, right knee, right



great toe, and left knee. He was treated on each visit with sheep serum and whole ovarian extract.

4-21-36: Readmission, at age of 10, because of a persistent, painful, discolored swelling and stiffness of the left knee of two months' duration. During this admission the right elbow became swollen spontaneously. Bleeding time 1 minute. Clotting incomplete in 10 minutes. Platelets 332,830. Symptomatic treatment and small transfusions. Discharge 5-11-36.

8-26-36: Readmission, at age of 11, because of a scalp laceration which had been bleeding for eighteen hours. Swelling and stiffness of both knees and right elbow of ten days' duration. Satisfactory response to blood transfusions and sheep serum.

3-7-37: Readmission because of hemorrhages into both elbows, left ankle, calf of left leg, and right thigh occurring during the preceding three weeks. Bleeding time 1 1/2 minutes. Clotting time 21 minutes. Response to treatment, with discharge 3-21-37.

5-1-37 to 7-1-38: The patient was seen in the clinic on numerous occasions for hemorrhages into both elbows, both knees, and left hand, right great toe, right cheek, and subcutaneously over the entire body. Treatment consisted of whole ovarian extract and sheep serum.

8-29-38: Readmission, at the age of 13, because of severe pain and stiffness in the left hip of twenty-four hours' duration and numbness of the left lower extremity. Treatment by traction, transfusions, and sedation. Discharged improved 9-11-38.

11-11-38: Seen in clinic because of a painful swelling on the anterior surface of the left tibia just below the knee. The knee was also swollen but not painful.

*Present Illness:* About three months prior to the patient's final admission, in 1939, he received a slight injury to the upper third of the left shin. Slight swelling occurred over the area but remained localized until three weeks prior to admission, when it began to increase gradually in size. During the two weeks preceding admission the swelling became firm, red, warm, and very painful. During this period the patient lost appetite and weight.

*Physical Examination:* Temperature 100°. Pulse 102. Respirations 18. The patient appeared pale and listless. The general physical examination was negative except for the following: (1) A firm swelling about 10 cm. in its greatest diameter over the anterior surface of the proximal third of the left tibia. The skin over this area was tense and shiny, with areas of reddish-brown discoloration; it was warm, and very tender to touch. (2) Slight swelling and stiffness of the left knee, which was held in about 30° flexion. (3) Slight swelling and limitation of motion of the right knee. (4) Swelling and slight stiffness of the left elbow. (5) Ecchymosis over the right upper arm.

*Laboratory Examination:* Hemoglobin 10 gm.; red cells 4,300,000; white cells 7,700; differential

count normal; platelets 473,760. Clotting time 6 minutes. Bleeding time 2 minutes. Kline and Mazzini tests negative. Urinalysis normal.

*X-ray Examination (1-9-39):* Roentgenograms of the left knee showed destruction of the cortex and underlying cancellous bone in the anterior aspect of the proximal third of the tibia, with undermining of the tibial tuberosity; thickening and elevation of periosteum with "cuff" formation on the anterior and lateral aspects of the tibia at the level of the lower limits of the overlying soft tissue tumor; deepening of the intercondylar notch of the femur; evidence of subchondral necrosis in the condyles of the femur. Impression: (1) Old hemarthrosis; (2) sarcoma of tibia.

*Clinical Course:* The patient's blood was typed and cross matched with several donors and he was given a 400 c.c. citrated blood transfusion. The pain was worse at night; local heat and swelling persisted. The temperature continued irregular, varying from 100° to 102.5°. Orthopedic consultation suggested the following possible diagnoses in the order given: (1) hemangioma of bone; (2) osteomyelitis; (3) osteogenic sarcoma. Conservative treatment except for aspiration was advised. On Jan. 10, the left knee joint was aspirated with a 2 1/2-inch No. 18 needle. The needle penetrated tissue more resistant than normal for the first 2 1/4 inches; fresh blood under considerable pressure was encountered by the last 1/4 inch of the needle. A specimen of blood (20 c.c.) was sent to the laboratory, but culture was sterile and no tumor cells were found.

The patient was presented to the weekly seminar and it was generally thought that the lesion of the left tibia was probably a neoplasm rather than an infection or hemangioma of bone. Aspiration biopsy followed by x-ray therapy was recommended.

Roentgenograms of the chest and skull (Jan. 21, 1939) were negative for secondary neoplastic growth and other disease. Aspiration biopsy of the tumor yielded thick red material which clotted quickly. Microscopic study was negative for tumor tissue, revealing only blood.

From Jan. 23 to Feb. 8, inclusive, 1,600 r (measured in air) were administered in daily doses of 200 r to alternate medial and lateral 15 × 15 cm. fields over the tumor below the left knee. The physical factors used were 200 kv., Thoraeus A filter, 50 cm. T.S.D., H.V.L. 1.35 mm. Cu.

On Feb. 3 a roentgen study of the left leg (Fig. 2) revealed an extension of the tibial lesion inferiorly. The cortex was destroyed over an area 5.5 cm. in length. There was a marked periosteal reaction present at the inferior margin of the tumor. The original film revealed some faint areas of calcification in the soft-tissue tumor medial to the destroyed area in the bone. Diagnosis: Bone sarcoma.

On Feb. 6 and 7 doses of 75 r (air) were delivered

through a 15 × 15 cm. field over the spleen, with the same physical factors that were used in treating the leg. This was given in an attempt to control the continued bleeding.

In addition to the x-ray therapy small daily blood transfusions and symptomatic treatment were given. The increase in the size of the tumor was apparently arrested for a few days, although other hemorrhagic lesions appeared over the body.

The tumor again began to enlarge and central necrosis of the skin developed over the lesion. On

neoplastic tissue appeared to fill this defect. On the anterior surface of the tibia in its proximal third was an area of bone denuded of periosteum, but again no neoplastic tissue was seen grossly. A piece of crushed homologous muscle was used to fill the defect in the proximal end of the tibia at the growth line, the presumable site of the original hemorrhage, and the cavity previously filled by hematoma was closed by a compression bandage held in place by an Ace bandage following closure of the incision.

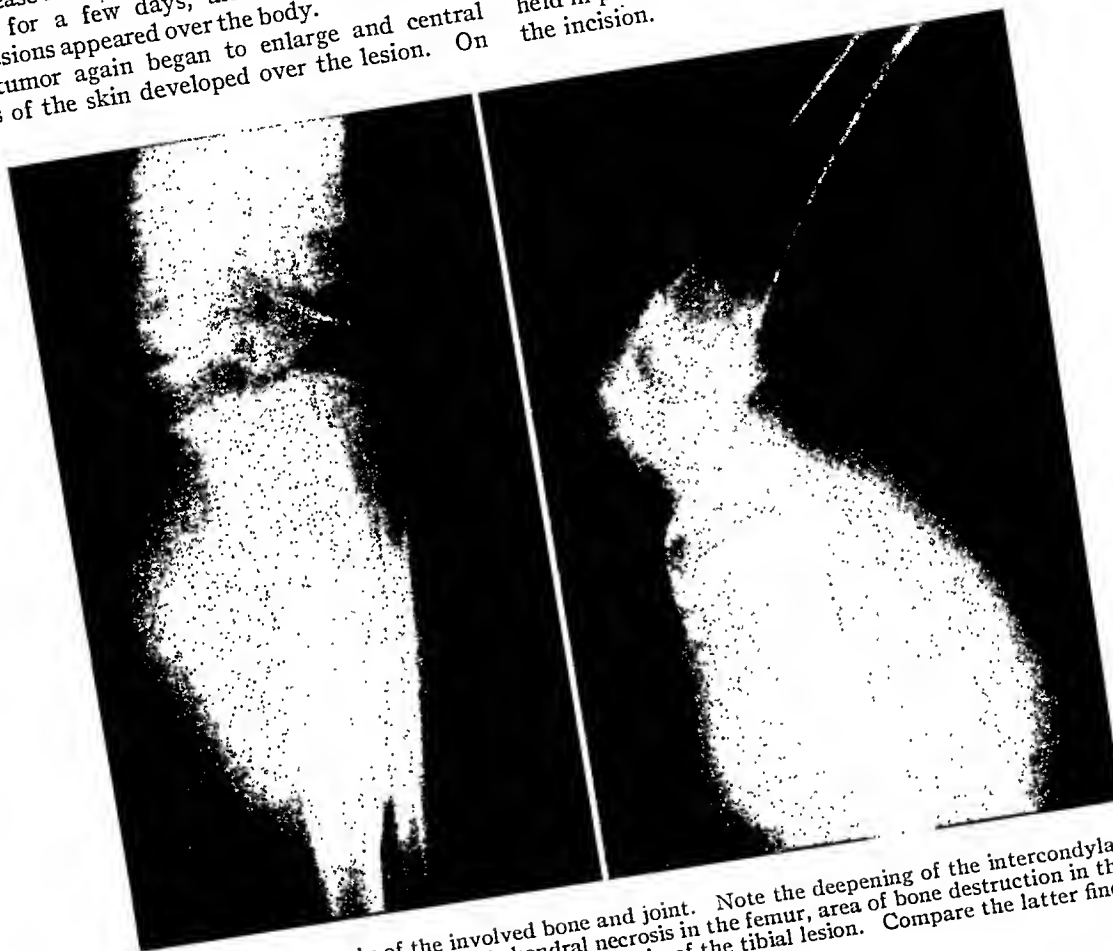


Fig. 2. X-ray study of the involved bone and joint. Note the deepening of the intercondylar notch of the femur, the areas of subchondral necrosis in the femur, area of bone destruction in the tibia, and the periosteal "cuff" on the lower margin of the tibial lesion. Compare the latter findings with those in Fig. 3.

Feb. 10 an exploratory incision by electrocautery was made through the skin and deep fascia on the antero-medial margin of the tibia and the overlying tumor. Beyond the deep fascia a mass of old blood clot was encountered. This was expressed in fragments and the entire tumor was found to be filled with hematoma of varying age. Those on the anterior margin of the leg beneath the point of impending skin necrosis showed partial organization. A specimen was sent to the laboratory for study. Digital and visual exploration of the anterior margin of the tibia, which was exposed after evacuation of the hematoma, disclosed a bony defect in the proximal end of the diaphysis adjacent to the epiphyseal line and joint capsule. No

Microscopic study of the specimens revealed blood and fibrinous clot, degenerated periosteum, and osteoid tissue. No neoplastic tissue was found.

The patient experienced relief of pain following the evacuation of the hematoma. No bleeding occurred until the third postoperative day, when slight hemorrhage was noted. There was no hemorrhage and the wound was dry when the dressing was removed on the fourth day. It was noted, however, that the point of impending skin necrosis anteriorly over the tibia had become definitely necrotic.

On Feb. 18, the seventh postoperative day, the patient became restless and complained of severe pain in the left knee, finally requiring morphine for relief. He then complained of pain in the right

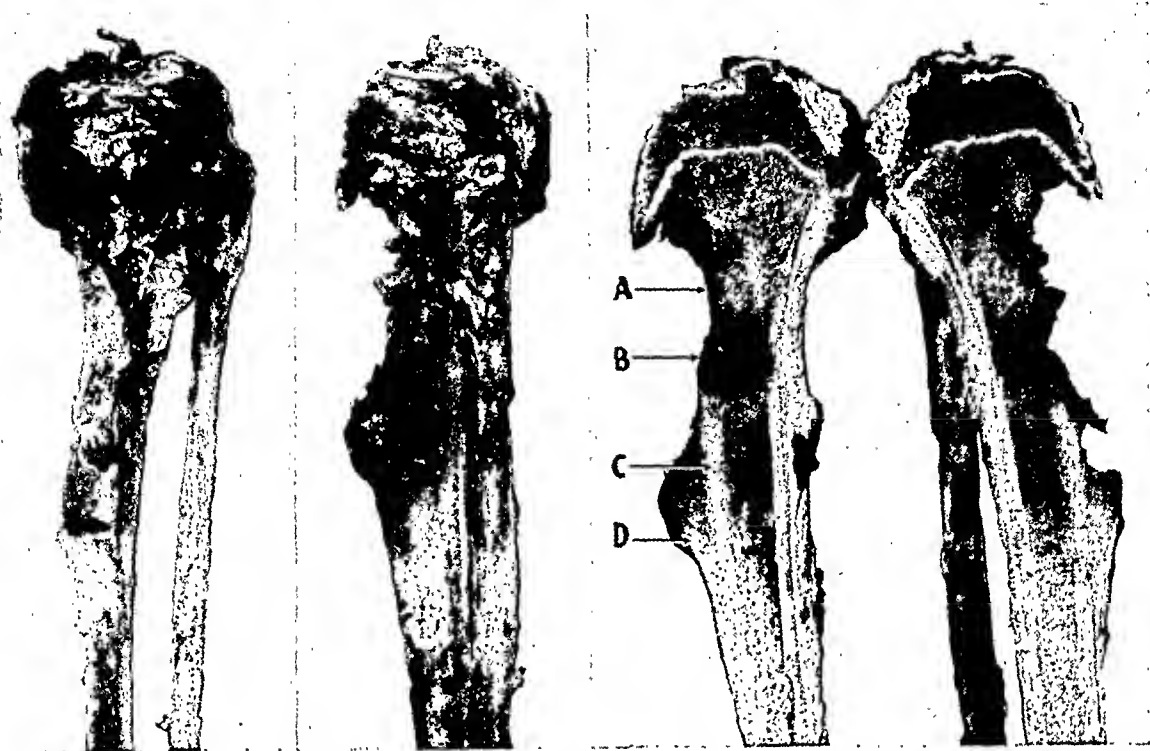


Fig. 3. Longitudinal section of the disarticulated left tibia. A. Eroded bone. B. Area of cortical necrosis and hemorrhage. C. Limits of normal cortex. D. Thickened periosteal "cuff."

upper quadrant of the abdomen and vomited. The liver was enlarged and tender. Upon removal of the surgical dressing, blood spurted across the room and bright red blood then drained continuously. A tourniquet was applied and 15 c.c. of fresh blood were injected into the evacuated area of bone. Bleeding ceased and the tourniquet was slowly released without further immediate bleeding. The following day bleeding began and could not be controlled. The hemorrhage appeared to be coming from the denuded bone. After all other measures failed, a disarticulation amputation at the knee was done. The operative note follows.

"Under nitrous oxide, oxygen and ether analgesia the skin around the left knee was washed with tincture of green soap and prepared with tincture of merthiolate. With a pneumatic bandage around the upper thigh, skin flaps were outlined with the electrosurgical knife below the knee joint, leaving as much skin as was possible without getting into the necrotic area. Upon cutting through the skin it was found that the hematoma below the anterior tibial tuberosity had extended posteriorly and superiorly into the popliteal space and the surrounding tissues were somewhat damaged by pressure necrosis. Despite this fact, it was felt that the advantage of the disarticulation leaving some necrotic tissue would outweigh the possible advantage of doing an amputation at the thigh through healthy tissue but leaving raw bone which

could bleed from the medullary cavity. Accordingly a disarticulation was performed at the knee. Popliteal vessels were isolated and ligated doubly with heavy black silk and again with chromic catgut No. 1. The tourniquet was released above the knee and bleeding was found to be controlled except for slight oozing. Fascia was brought together over the end of the femur with chromic catgut No. 1, subcutaneous tissues were approximated with hemostatic sutures, and the skin closed with black silk without undue tension. A light dressing was applied and the patient was not bleeding when he left surgery in fairly good condition."

The patient was treated with sedation and small blood transfusions following amputation.

On Feb. 22, the third postoperative day, the thigh became considerably swollen and painful. Fresh bleeding occurred from the stump, the patient's general condition grew rapidly worse and death occurred.

The pathological report on the amputation specimen follows. "The disarticulated left leg shows enormous swelling in the region just below the knee. A large defect in the skin occupies the antero-medial aspect just below the knee joint. Over the tumor and beneath it, apparently composing the tumor, is a mass of deep red, jelly-like blood clot. Posterior and medial to this area is a closed recent biopsy wound. The soft tissue was removed and the bone and joint studied. The cavity occupied

by the blood clot has a multilocular appearance and is lined with relatively smooth connective tissue. The hemorrhagic area seems to stop at the epiphyseal line. The joint shows evidence of some cartilaginous destruction with replacement of some of the joint cartilage by fibrous tissues, which it is suspected represents the results of previous hemarthrosis. On longitudinal section (Fig. 3) an erosion through the anterior cortex of the tibia down deep into the cancellous portion is found. In the deepest portion hemorrhagic necrotic areas extend practically to the cortical bone on the posterior side. The epiphysis above the defect is undermined by the process of bone destruction, and the lowermost portion of the crater shows a shelf-like area of persistent, though uncovered, cortical bone and cuff-like swelling of the periosteum which shades off into the normal periosteum below.

"Micro-sections through the joint surface show replacement fibrosis of some of the joint cartilage and evidence in this fibrous tissue of old hemorrhages. The blood vessels about this area show a very pronounced endarteritis, presumably due to x-ray therapy. In fact, the blood vessels of all the sections studied show this severe endarteritis. Sections through the thickened periosteum at the margin show a superficial layer of hemorrhagic fibrino-purulent exudate which lies above the extremely thickened and hemorrhagic periosteum. Sections of the cancellous bone show the bone spicules somewhat atrophic and nowhere in the sections do we find evidence of bone regeneration either in the cancellous or in the periosteal tissue surrounding the defect in the bone. Numerous sections made from various portions of the bone show no indication of neoplasm.

"*Diagnosis:* Large subperiosteal hematoma with massive necrosis of the underlying bone and necrosis and infection of the overlying skin."

#### DISCUSSION

Much has been written about the roentgenographic findings in the various stages of hemophilic arthritis. In general these can be divided into three stages comparable to those of Koenig (12), based upon the pathological changes: (1) simple hemarthrosis with swelling of the joint capsule and surrounding soft tissues and clouding of the joint; (2) a panarthritis with progressive destruction of the cartilage and ends of the bones, deepening of the intercondylar notch of the femur due to the expanding hematoma, much like the erosion due to an aneurysm, punched out areas of destruction in the subchondral bone, bony lipping at the

joint margins, organization and calcification within the hematoma; (3) a tendency toward healing by the production of fibrous or osseous ankylosis—arthritis deformans.

Little has been written regarding any findings in the shafts of the bones. A rather complete review of the available English and foreign literature reveals the fact that at least three cases similar to ours have been reported, two involving the femur and one the bones of the thumb.

Starker (23), in 1918, reported the first case of its kind that he could find in the literature. The patient was a 14-year-old boy, a known hemophiliac, who presented himself because of a painful tumor on the right thigh, the size of his head. This had been present for eight months. The skin over the tumor was tense and discolored. The clinical diagnosis was sarcoma of bone and hemophilia. X-ray studies revealed a soft-tissue tumor surrounding the distal half of the femur,  $9 \times 22$  cm., with periosteal elevation and reaction at the superior border of the tumor 2 cm. in length, thinning of the cortex, and in places destruction of the cortex and spongiosa in the metaphysis, and bone proliferation at right angles to the shaft. The x-ray diagnosis was sarcoma of the bone. Biopsy and amputation were not done because the patient was known to be a bleeder. The tumor was probed and 750 c.c. of pure blood were aspirated, with disappearance of the tumor, leaving a flabby sac. The sac refilled in four days and the patient died ten days later. Autopsy revealed a hematoma  $2.5 \times 15$  cm. over the anterior aspect and  $6 \times 22$  cm. over the posterior aspect of the femur. The hematoma had a fibrous capsule. The periosteum was ossified at the superior border 1 to 4 mm. thick. There was erosion of the cortex and spongiosa beneath the hematoma at the lower end of the femur. Calcified connective-tissue strands extended from the cortex to the elevated periosteum on the anterior surface. Histologically no evidence of neoplasm was seen. The author concluded by stating that a hematoma with ossification in its

wall is hard to differentiate from neoplasm roentgenologically.

Reinecke and Wohlwill (17) reported the case of a 27-year-old male who was a known bleeder, having had numerous episodes of bleeding into various joints. The patient presented himself for treatment because of an enormous swelling of the soft tissues of the thigh, which was thought to be due to an old and recent soft-tissue hemorrhage. The knee was aspirated and liquid blood under high pressure was obtained. Three months later a high temperature suddenly developed, the patient became anemic, showed signs of generalized infection for six days, and died. Post-mortem x-ray studies revealed roughening of the cortex of the femur with erosion resembling that seen in the vertebrae and sternum due to aortic aneurysm. There was also evidence of periosteal new bone formation on the lateral aspect of the femur. The pathological report was as follows: "Sagittal section of the femur reveals the middle half of the bone to be surrounded by an extensive subperiosteal hematoma measuring 10 cm. in length, 2 cm. in width on the medial aspect, and 7 mm. on the lateral aspect. There is irregular erosion of the bone beneath the hematoma, and above and below the hematoma the periosteum is thickened and shows periosteal new bone formation. Microscopic studies reveal no tumor tissue, only sequestra, granulation tissue, and some giant cells."

Firor and Woodhall (24) reported the case of a 16-year-old male who was also a known hemophiliac. Their patient had a painful swelling of the right thumb which had been previously x-rayed and diagnosed as bone sarcoma. The entire thumb was involved in a globular, symmetrical enlargement extending from the metacarpophalangeal joint laterally and medially to the web space. The skin was shiny, reddish-black in color, and perforated at one point, from which there was a slow constant effusion of thick, dark blood. X-ray examination revealed destruction of both phalanges and the metacarpal of the

right thumb. The suggested diagnosis was new growth. The tumor was aspirated in an attempt to control the severe, constant pain. The lesion continued to bleed and remained swollen and painful. It was finally decided to attempt amputation. This was successfully done by electrocautery with no excessive bleeding. The postoperative diagnosis was destruction of bone by pressure from a hematoma with no evidence of tumor. The authors concluded that lesions such as that in their case, involving small articulations, may not reach the final stage of hemarthrosis due to the weaker joint structures and their resultant inability to check the expanding hematoma.

#### SUMMARY

Hemophilia may cause subperiosteal hemorrhages with resultant proliferation and thickening of the periosteum, erosion of the underlying cortex and cancellous bone, and organization and calcification of the hematoma, producing roentgen changes resembling bone sarcoma. Such a case is presented and three similar cases from the literature are briefly reviewed.

NOTE: The author wishes to acknowledge the invaluable assistance of Dr. Charles F. Roland, Resident in Radiology, Indiana University Medical Center, in the translation of the foreign literature.

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# Diffuse Calcification of the Placenta Demonstrable in Vivo<sup>1</sup>

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CALCIFICATIONS in the placenta occur normally and should not arouse suspicion of disease in the mind of the radiologist or obstetrician. Pathologists have calcifications occur on the maternal side of the placenta in fine linear areas of degeneration of the syncytial-like structure known as the trophoblast. The amount of

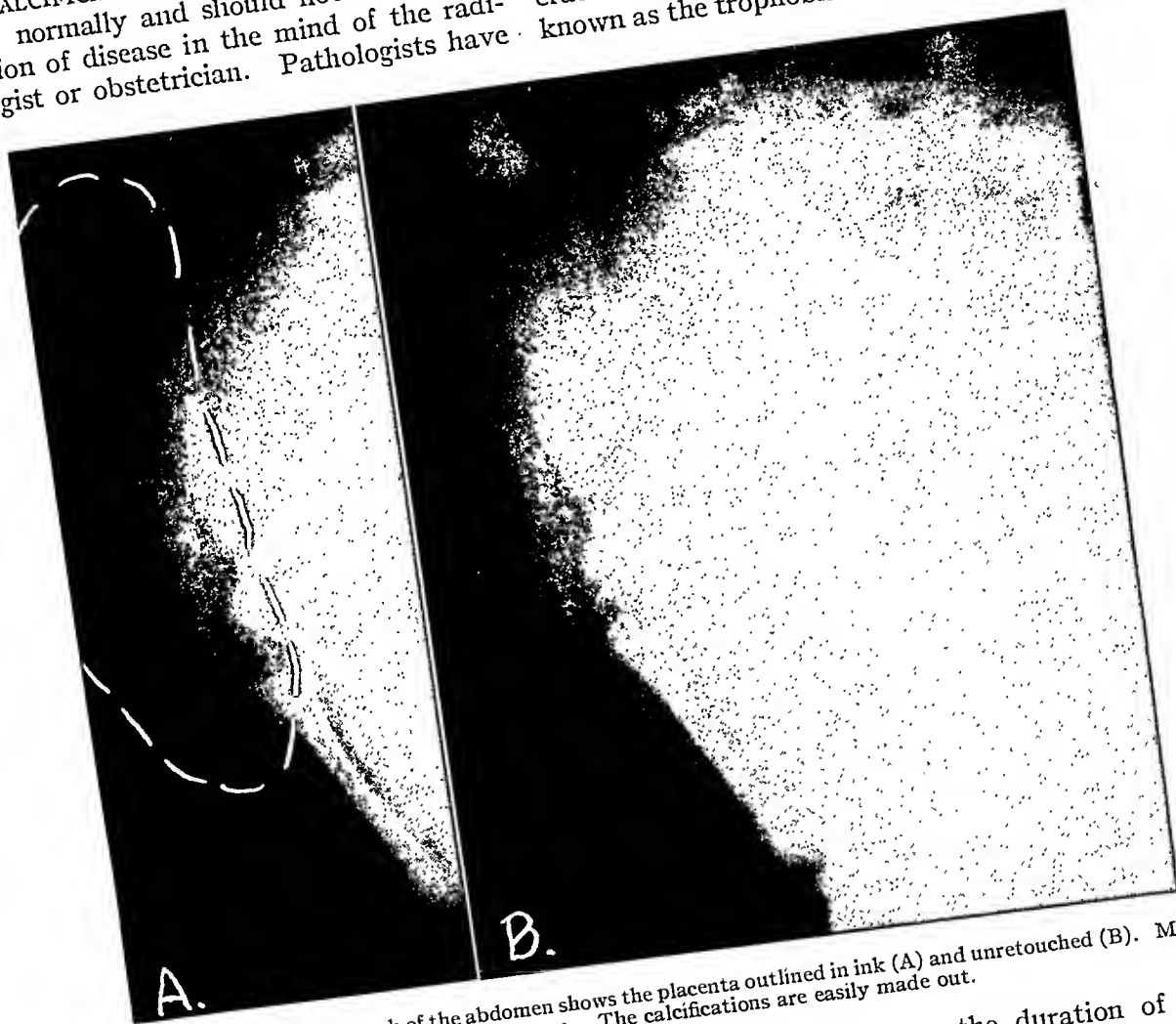


Fig. 1. The lateral radiograph of the abdomen shows the placenta outlined in ink (A) and unretouched (B). Much of the fetus is also seen. The calcifications are easily made out.

known for a long time that microscopic and even macroscopic areas of calcification in the mature placenta are quite normal (1). The process is a simple degenerative one and not usually associated with any fetal or maternal disease. The

calcium depends on the duration of the pregnancy (2) and also on the calcium metabolism of the mother (3).

One reason why these opacities have not been reported by radiologists is the nature of the calcification rather than its absence. Because the calcifications are minute and are spread over a wide area, with a thick soft-tissue mass beneath; because the fetus frequently is moving or the uterus

<sup>1</sup> From the Department of Radiology, San Francisco Hospital, San Francisco Department of Public Health (J. C. Geiger, M.D., Director), and Leland Stanford University School of Medicine. Accepted for publication in June 1943.





Fig. 2. More detailed reproduction than Fig. 1, showing the reticular pattern of the placental calcifications.

contracting; because of the motion transmitted by the uterine or aortic vessels; and sometimes because the radiographic screens are worn or the focal spot of the tube is large, calcifications in the placenta are not often seen in examination of the pregnant uterus. With the advent of the rotating anode tube and general improvement in technic one must expect that they will be seen more often.

#### CASE HISTORY

A 19-year-old primipara in good health was first seen toward the end of the fifth month of pregnancy. The only remarkable finding at that time was poor dental hygiene. One month before her delivery date she entered the hospital complaining of painless bleeding for three days. The exact date of conception was in question due to irregular bleeding. The possibility of a placenta praevia was considered and films were made to localize the placenta. In the

lateral film of the abdomen numerous opacities were seen within the placental shadow (Fig. 1). Vaginal examination revealed an ulceration on the posterior lip of the cervix. The patient gave birth to a normal female child weighing 8 pounds and 3 ounces after a sixteen-hour labor on the estimated 324th day ( $10\frac{1}{2}$  months) of her pregnancy.

#### SUMMARY AND COMMENT

A case of diffuse calcification of the placenta is presented. The finding of calcification in the placenta has not previously

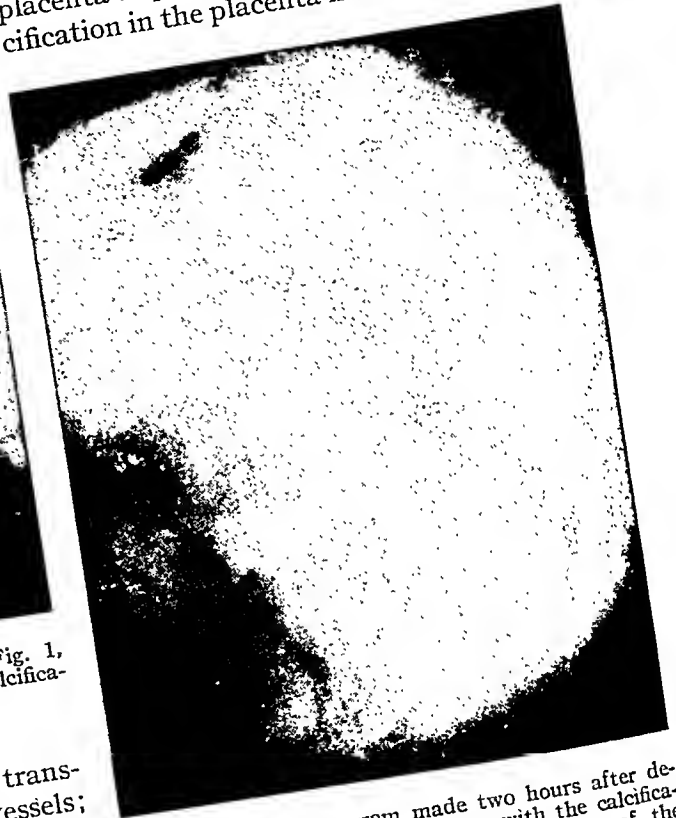


Fig. 3. Roentgenogram made two hours after delivery, showing the intact placenta with the calcifications, which are heaviest at the periphery of the cotyledons.

been described in the radiological literature. The patient was a 19-year-old primipara, gravid some ten months. The long pregnancy correlates nicely with the carefully worked out studies of Masters and Clayton, who found that the longer the pregnancy the larger are the amounts of calcium (normally) found in the placenta. The presence of calcifications in the placenta should not lead to a diagnosis of disease. The reticular pattern of the calcification should always be looked for in suspected placenta praevia; its loca-

tion may obviate special procedures such as iodide or air cystography.

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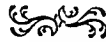
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# Pneumonic Densities Obscured by the Cardiac Shadow<sup>1</sup>

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FROM A SURVEY of an extensive series of roentgenographically proved pneumonias, it has become manifest that areas of pneumonic density may sometimes be obscured by the cardiac shadow on the roentgenogram. Since approximately two-thirds of this shadow lies on the left side of the thoracic spine, it overlaps the mesial and lower portion of the left lung in the routine postero-anterior view. An analy-

The fact that a pneumonic process may be obvious roentgenographically in one portion of the chest does not rule out the possibility of another pneumonic lesion hidden behind the cardiac shadow in the left lung (Fig. 2).

The recognition of a pneumonia obscured by the cardiac shadow is an important factor in the differential diagnosis of intra-abdominal and intrathoracic diseases, for

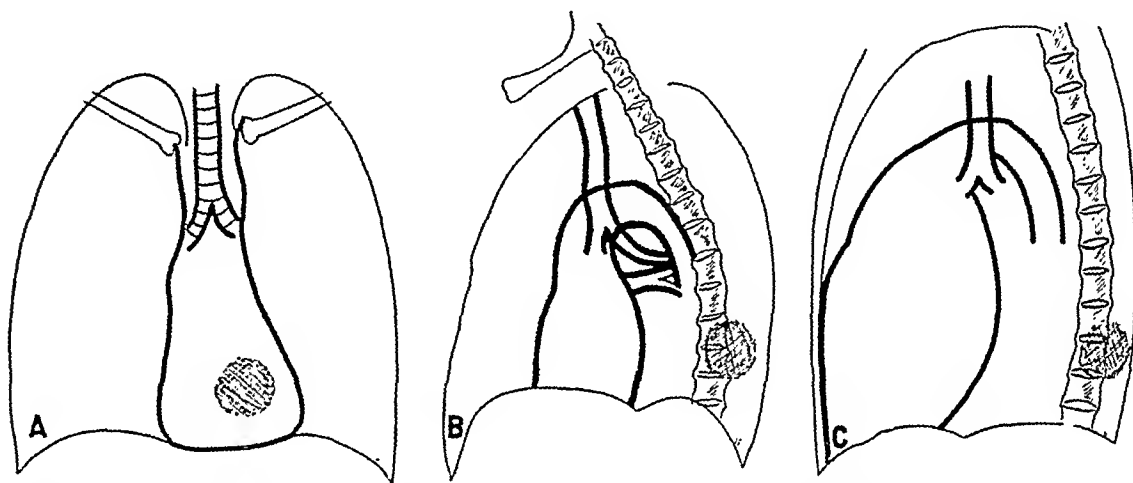


Fig. 1. Case 1: Pneumonic process overlying the bodies of the lower dorsal vertebrae. Tracings from postero-anterior, left oblique, and lateral roentgenograms. A. Postero-anterior projection: pneumonic density obscured by the cardiac shadow. B. Left oblique projection localizing pneumonic process in left lower lobe. C. Lateral view, localizing the process posteriorly in the left lower lobe.

sis of the structures portrayed on the roentgenogram of this area reveals a superimposition of the lung itself with its bronchovascular markings, the ribs and the costovertebral articulations, and the heart shadow. In the normal subject, this area should appear as a fairly homogeneous shadow. Any variation or change in the uniformity of the density should arouse suspicion of the presence of a pneumonia in this region. Further radiological examination with left oblique or left lateral projections should make it possible to rule out or confirm such a process, which might otherwise be overlooked (Figs. 1 and 3).

<sup>1</sup> Accepted for publication in May 1943.

it may prevent needless operative exploration, as in Case 1, reported here. Meningeal irritation may be of pneumococcal origin, and here, too, a complete pulmonary examination with multiple views is necessary.

A pneumonia may be present in the left lower lung field with the mesial portion extending behind the heart. In spherical pneumonic consolidations this creates a curious *half-moon* effect. The use of an over-exposed film technic will demonstrate this satisfactorily (Fig. 4).

CASE 1: Pfc. H. D. M., aged 21, entered the Station Hospital, A.A.F.T.S., Sioux Falls, South Dakota, on April 8, 1943, with nausea and vomiting,

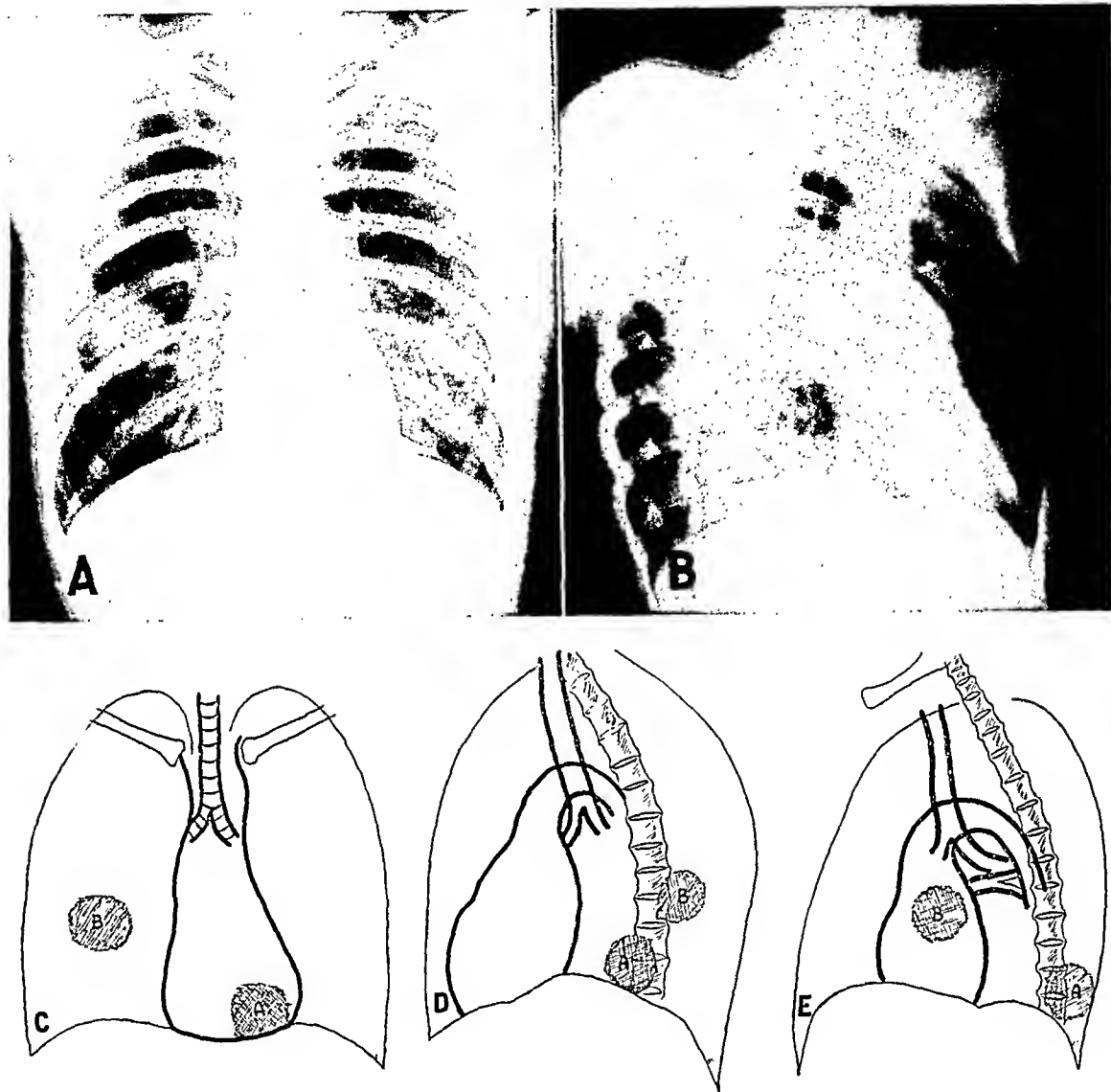


Fig. 2. Case 2: A. The spherical pneumonic density in the right lung is easily identified in the postero-anterior view, but the increased density in the left lower lobe is obscured by the heart shadow. B. In the right anterior oblique view both areas of density are separated from the cardiac shadow and are easily seen.

C, D, and E. Tracings of the postero-anterior, right anterior oblique, and left anterior oblique roentgenograms. Note how easily the pneumonic density (labeled A in the diagram) can be overlooked in the conventional postero-anterior projection (C), since the focus of attention is drawn to the more obvious lesion in the right lung (labeled B in the diagram). The right anterior oblique projection (D) readily demonstrates the presence of the two pneumonic processes. The left anterior oblique projection (E) localizes the pneumonic density previously obscured by the cardiac shadow in the region of the left lower lobe. It is interesting to note that in this oblique view the pneumonic process in the right lung is obscured by the cardiac shadow.

pain in the epigastrium, and tenderness in the right abdominal quadrant. A tentative diagnosis of appendicitis was made and the patient was admitted to the surgical service. Cough and expectoration were noted and physical examination revealed dullness and fine râles over the left base posteriorly. The temperature was 103.2°, pulse 118 and respirations 22.

X-ray examination of the chest, April 8, 1943, dis-

closed a pneumonic density in the left lower lobe, obscured by the cardiac shadow in the postero-anterior view, but visible on oblique and lateral projections. The patient was transferred to the medical service and a diagnosis of lobar pneumonia was made. A blood count taken the same day showed 22,400 white blood cells, with 93 per cent polymorphonuclears and 7 per cent lymphocytes. No significant changes were observed on urinalysis.

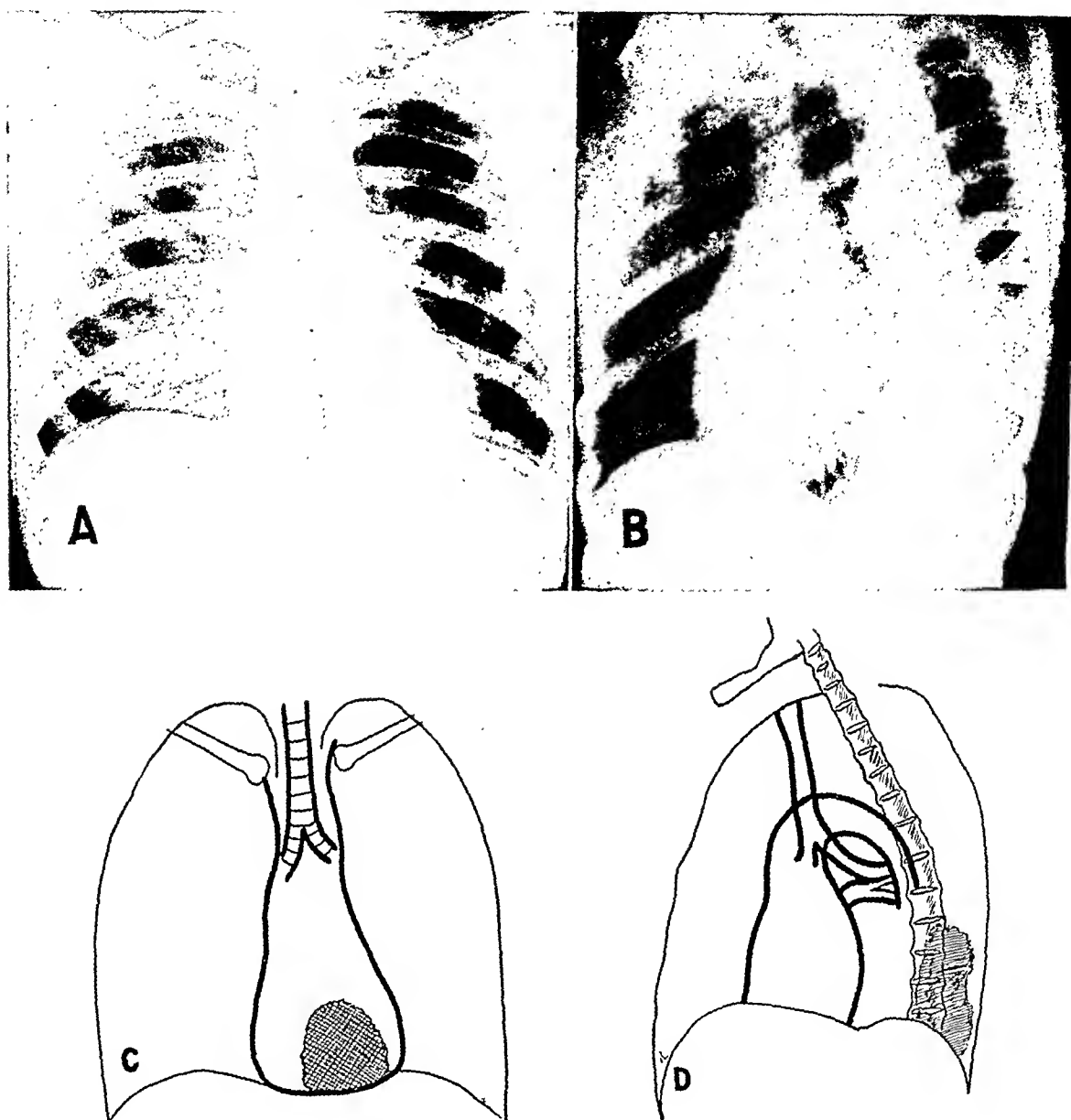


Fig. 3. Case 3: Pneumonic density hidden by the cardiac shadow in the postero-anterior view (A and C) but readily discernible in the left oblique projection (B and D).

Sulfadiazine therapy was administered and resolution of the pneumonic process progressed satisfactorily.

CASE 2: Pvt. R. A. O'D., aged 18, was admitted to the Station Hospital on February 23, 1943, with pain in the left side of his chest, severe chills, cough with expectoration of yellow sputum, malaise, and vomiting. The temperature on admission was  $102^{\circ}$ , pulse 112, respirations 22. A moderate injection of the pharynx was observed on physical examination. Crepitation in the left cardiophrenic area and numerous harsh rhonchi were heard in the left base. A blood count showed 5,170,000 red blood cells

and 18,100 white blood cells with 90 per cent polymorphonuclears and 10 per cent lymphocytes. Urinalysis revealed nothing significant.

X-ray examination of the chest disclosed a pneumonic process involving the right middle lung zone, on a plane with the 5th rib anteriorly. It was requested that oblique and lateral views be taken to rule out an additional pneumonic density behind the heart in the left base.

A Group B, Type 5 pneumococcus was isolated from the patient's sputum on Feb. 24, 1943. Oblique roentgenographic projections taken the same day confirmed the presence of a pneumonic process

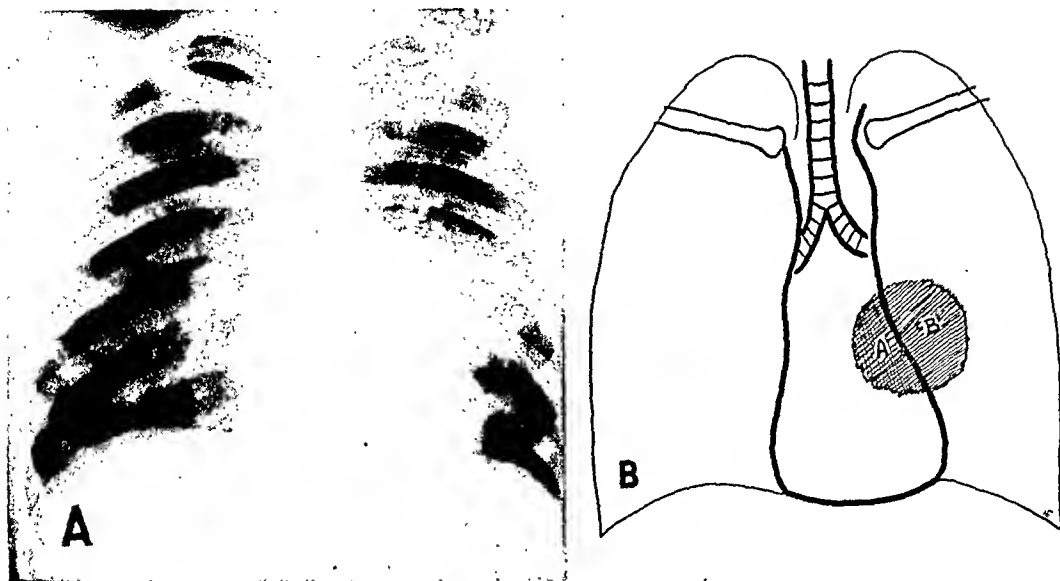


Fig. 4. Case 4: Curious half-moon effect created by that portion of the pneumonic process lying beyond the cardiac shadow. The remaining portion of the process obscured by the heart completes the spherical configuration.

in the left base, previously obscured by the cardiac shadow.

A diagnosis of bilateral lobar pneumonia was made and the patient was given sulfadiazine therapy. Following an uneventful course, he was discharged on March 22, 1943.

CASE 3: Pvt. T. N. M., Jr., aged 20, was admitted to the Station Hospital on Dec. 14, 1942, with cough, weakness, and fatigue, beginning two days previously. Physical examination revealed a slightly injected pharynx, and crepitant râles were heard in both lung bases. The temperature on admission was  $104.6^{\circ}$ , pulse 104, respirations 24. The blood count showed 11,600 white blood cells. Urinalysis was essentially negative.

X-ray examination of the chest on Dec. 16, 1942, disclosed a density obscured by the cardiac shadow in the postero-anterior projection. Oblique and lateral views taken Dec. 17, 1942, confirmed the presence of the pneumonic process in the left lower lobe.

The patient received sulfadiazine therapy for two days only, followed by routine care. An uneventful recovery ensued.

CASE 4: Pfc. P. J. M., aged 19, was admitted to the Station Hospital on March 26, 1943, with chills, backache, cough, and a sore throat. An injected pharynx was observed on physical examination and râles were heard in the left lung. The temperature was  $101.4^{\circ}$ , pulse 112, and respirations 24. Urinalysis showed nothing remarkable. The white blood count was 24,650.

X-ray examination of the chest on March 27 revealed a large spherical pneumonic process, involving the left hilum and the upper portion of the left lower lobe area. Sputum examination disclosed no response to typing serum.

The patient was put on sulfadiazine therapy and was discharged on April 11, 1943, following an uneventful recovery.

*Note:* Appreciation is hereby expressed for the co-operation of Colonel R. M. Allott, Medical Corps, and for the valuable assistance rendered by Major Harold Einhorn, Medical Corps, and Mark Derovan, Technician Fifth Grade.

A.A.F.T.S.  
Sioux Falls, S. Dak.



# March Fracture of the Tibia<sup>1</sup>

MAJOR GEORGE R. KRAUSE, M.C., A.U.S., and LT. COL. JOHN R. THOMPSON, JR., M.C., A.U.S.

ALTHOUGH "MARCH fractures" of the metatarsals have been encountered with increasing frequency (2, 6, 12, 13), similar "stress" fractures in the other weight-bearing bones are apparently much less common. More than 200 metatarsal march fractures have been observed at the authors' station, but until recently none had been seen in other bones. Three instances of march fracture in the tibia were then encountered within two months, and a search of the files revealed a fourth case.

Pfahler (10) reported a single instance of this type of fracture of the tibia at the meeting of the American Roentgen Ray Society in 1939. This "insufficiency fracture" had occurred in a high-school athlete. The fracture line was narrow, incomplete, and extended only through the thickness of the cortex. The callus resembled an osteogenic sarcoma, and Pfahler stated that up to that time he had never seen a fracture of this kind. Barth, in discussing the report, remarked that no such case had been seen in his clinic. Pfahler commented that such fractures had not been seen in this country because, up to that time, we had not had compulsory military training. In the European literature, on the other hand, as might be expected, a number of reports of march fractures of the tibia were to be found.

Aleman (1) stated that about 100 instances of *periostitis ab exercitio* are reported yearly in the Swedish army. He objected to the name and designated these cases as insufficiency fractures, although he had not observed the fracture line, but only the callus formation.

Ollonqvist (8), basing his report on twelve years of observation, stated that "march fractures" of the tibia occurred at the rate of 60 a year in the Finnish army. He called it *osteopathia itineraria tibiae*

and noted the presence of the fracture line. (It is possible that the extensive use of skis and snowshoes in the Northern European armies may have some relation to this large number of incomplete fractures in the tibia.)

Brandt (3) stated that march fractures of the tibia are usually located in the middle third and are next in frequency to those occurring in the metatarsals. He attributed this high incidence in the tibia to the rigid marching step used in the German army.

Hansson (4) reported a case of incomplete fracture of the tibia of this type and two similar fractures in the femur.

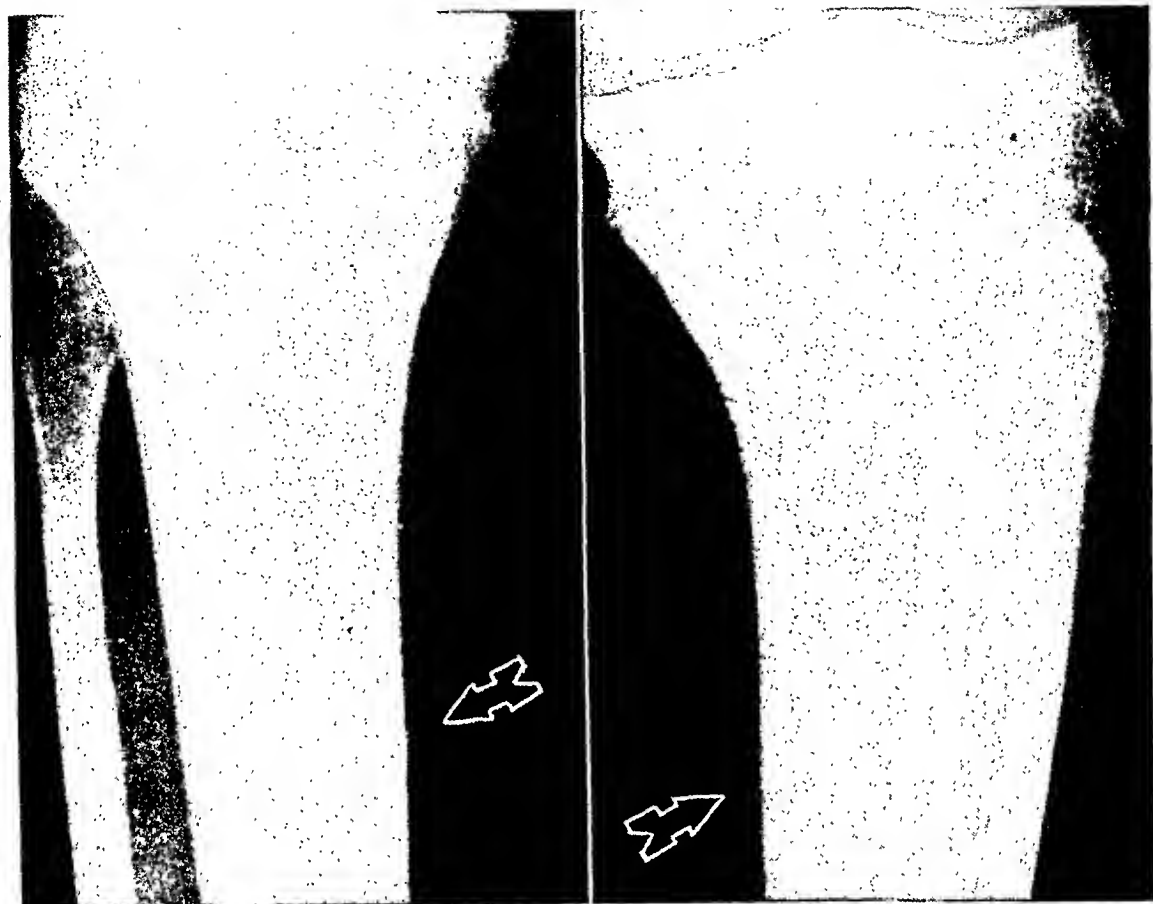
In 1942 Peterson (9) recorded a single instance of this type of fracture in the femur, and stated that the only similar cases in the English literature had been reported by Nordentoft (7) in 1941. The latter had described two march fractures in the tibia and two in the femur.

Roberts and Vogt (11), in 1939, described 12 cases of "pseudofracture" of the upper third of the tibia, without a history of trauma, in children ranging from four to sixteen years of age. While the roentgenologic appearance is quite similar to that described by Pfahler, Ollonqvist, and Hansson, the clinical picture differs in certain aspects from that seen in adults. The duration of symptoms in some of the cases was longer, in some there was active infection elsewhere in the body, and in two of them biopsy revealed chronic inflammation. The fractures seem, however, to be of the same type as those to be described in this report. One instance is strikingly similar to Case 4.

Hartley (5) recently reported 14 cases of "fatigue fracture" in the tibia, 3 of which he described in detail. Three patients, one of whom was a young soldier, suffered bilateral fractures. The age range in Hartley's series was much the same as

<sup>1</sup> Accepted for publication in June 1943.





Figs. 1 and 2. Case 1: Anteroposterior and oblique roentgenograms of right leg taken twenty-one days after the onset of symptoms. The anteroposterior view shows the narrow, incomplete fracture line extending through the cortex of the tibia on the medial border (arrow). A small amount of lightly calcified callus is visible in this view. Both the fracture line and callus are seen in the oblique view. The infraction of the cortex is on the postero-medial surface of the tibia at the junction of the upper and middle thirds.

that of the group reported by Roberts and Vogt.

Only two papers in the English literature deal with more than one or two cases of this type of fracture of the tibia and the patients have been, almost without exception, children or adolescents. A possible explanation of the apparently higher incidence in this group may lie in the physical activity of these youngsters.

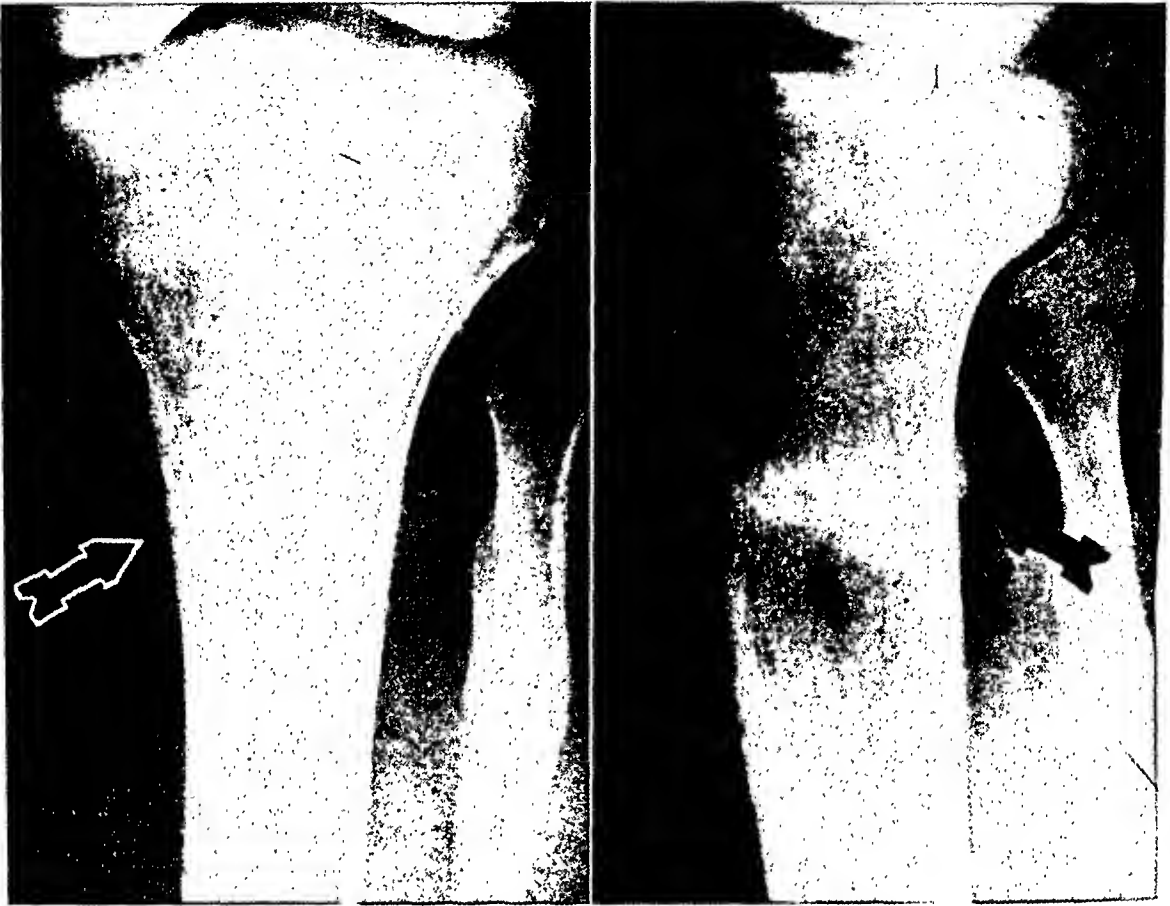
In the cases described by Pfahler and Peterson, in two of those reported by Hansson, and in three of those mentioned by Roberts and Vogt, a diagnosis of neoplasm of bone was seriously considered. This illustrates the point that the differential diagnosis between osteogenic sarcoma and these incomplete ("fatigue," "insufficiency," "march") fractures is most

important. This differentiation did not confuse the issue in the cases reported here because the fracture line was visible on all of our roentgenograms.

The mechanism, as in metatarsal march fractures, is probably a summation of minor, subthreshold traumata incident to marching, to a point beyond the capacity of the bone to bear stress (3, 4).

The most common site of march fractures of the tibia appears to be at the junction of the middle and upper thirds on the medial surface, although they do occur at other sites. The fracture line is usually incomplete and extends only through the cortex. It may be completed, however, by relatively slight injury.

Callus formation is seen early and is a prominent feature. It is often visible



Figs. 3 and 4. Case 2: Anteroposterior and lateral roentgenograms of the left leg. The anteroposterior view, taken five days after the onset of symptoms, demonstrates a narrow "Y"-shaped infraction of the cortex on the medial border of the tibia in its upper third (arrow); no callus is seen. There is an old healed fracture of the fibula incurred at the age of twelve. The lateral view, made one month after onset of symptoms, reveals a large amount of callus, which appears to extend across the shaft of the tibia (arrow). The callus is still fuzzy.

posteriorly, although the fracture line itself cannot be traced all the way. The amount of callus is more than adequate, probably because the gradual onset of symptoms permits continued walking and even full army duty for a time. Recovery is usually uneventful.

In view of the expansion of the armed forces of the United States, and the consequent probable increase in frequency of this type of fracture, the following four cases are submitted to draw further attention to the fact that the tibia is also subject to a march fracture.

#### CASE REPORTS

**CASE 1:** A 21-year-old soldier of medium build had had slightly less than three months' army service, when on March 5, 1943, while on a cross-

country march, he noticed a dull pain in the upper half of the right leg anteriorly. This pain was present with each step and gradually became worse, so that he had to fall out. Relief from pain was obtained as long as he did not bear weight on the right leg. Further attempts at walking caused recurrence of the pain. He was placed on quarters and instructed to rest the leg. Five days later swelling was present over the entire anterior surface of the tibia. The relationship of the pain to weight-bearing was more pronounced.

Ten days after the onset he was admitted to the hospital with the tentative diagnosis of osteomyelitis. Physical examination revealed edema over most of the anterior surface of the leg, with tenderness at the junction of the middle and upper thirds. Roentgenograms revealed a narrow incomplete fracture line on the medial aspect of the tibia at the junction of the upper and middle thirds.

Other roentgenograms (Figs. 1 and 2) eleven days later (twenty-one days after the onset) showed definite callus formation. The fracture line was still visible.

*Comment:* This is a typical history of a minor infraction of the cortex resulting from marching and follows in every detail the history usually obtained in similar fractures of the metatarsals, varying only in the site of pain.

**CASE 2:** A 28-year-old soldier of slender build first complained of pain on the lateral aspect of the left leg on Jan. 9, 1941, during calisthenics (running-in-place exercise). At that time he had had three months' service in the army. The pain was not severe and was present only on motion of the leg and on weight-bearing. He continued with his duties for the following few days, but the pain gradually became more severe and the relation to weight-bearing very evident. A roentgenogram made on Jan. 14 (Fig. 3) showed a tiny incomplete fracture of the cortex of the medial border of the tibia about 5 cm. from the articular surface. The fracture line was not recognized by the officer in charge of the department at that time.

The patient continued on duty and two days later noticed slight edema and tenderness just below the left knee joint on the anterior aspect. He was then admitted to the Station Hospital. Physical examination was negative, except for definite tenderness in the area mentioned.

Another roentgenogram on Feb. 9 (Fig. 4), one month after the onset, showed definite lightly calcified callus at the site of the fracture line, which was now easily recognized. The patient made an uneventful recovery.

*Comment:* This is a typical example of a fracture of the cortex of the tibia, in the absence of a single direct trauma, in a soldier undergoing basic training. The fracture line was so narrow that it was overlooked on the first examination, but the nature of the injury was clearly evident when callus formation was seen. The clinical history was characteristic.

**CASE 3:** A 24-year-old soldier of slender build had had three months of army service, when early in April of 1943 he noticed a small area of ecchymosis over the lower portion of the right tibia. There was no pain and the discoloration disappeared in two days. He had neither bumped nor injured his leg in any manner. Three days later he experienced pain in this area while marching. This gradually became worse, and after a week a small lump (callus) was palpable. He continued on duty but the pain became worse, especially on long marches. During rest periods a dull ache was present. The patient first reported to his unit dispensary on May 5, 1943, and was sent to the hospital for roentgenographic study. Roentgenograms taken that day

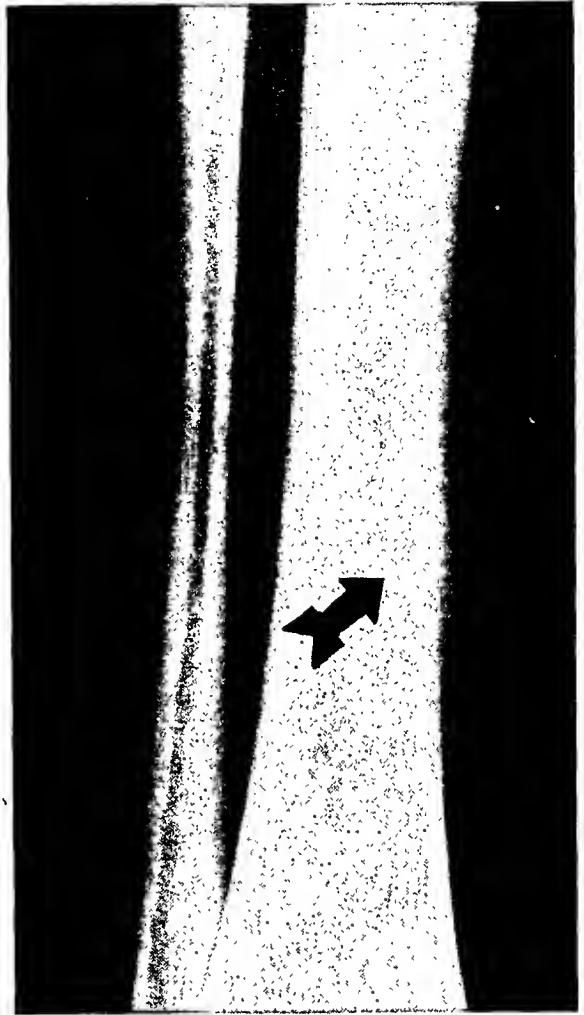


Fig. 5. Case 3: Anteroposterior roentgenogram of the right leg made one month after the onset of symptoms, showing an oblique fracture through the cortex of the medial surface of the tibia in the lower third. A cap of well defined callus covers the fracture.

and on May 7 (Fig. 5) revealed a narrow, incomplete fracture line through the cortex of the lower third of the tibia on the medial side. A cap of well demarcated callus covered the fracture.

*Comment:* This is a characteristic story of an incomplete fracture, in this instance in the lower third of the tibia. It resembles the preceding two cases, varying only in the location of the fracture. The patient was first examined one month after the onset of symptoms, at which time both the callus and the fracture line were demonstrable.

**CASE 4:** A stocky 25-year-old soldier, having had 2 months' army service, was first admitted



Fig. 6. Case 4: Anteroposterior roentgenogram of the right leg, showing an oblique, complete fracture through the distal and middle thirds of the tibia. There was no direct injury to the leg, and the patient denies twisting it in any fashion. This fracture occurred spontaneously during marching. Bone texture is normal. Healing was uneventful.

to the Station Hospital on Jan. 12, 1943, complaining of pain in the left foot. This was aggravated by walking and there was a slight edema of the dorsum of the left foot. Roentgenograms revealed a march fracture of the third *left* metatarsal, which was treated by rest, physiotherapy, and a metatarsal bar. The patient was discharged from the hospital on Feb. 13, with the fracture healed. On Feb. 15 he participated in the usual company training, including drill. Toward the end of the day he noticed a dull ache on the anterior portion of the *right* tibia. Routine drill and duty activities aggravated the pain, which was still not severe and was present only while bearing weight on the right leg. On the morning of Feb. 17, during "double-time" marching, the pain became worse, but was still present only on weight-bearing. The patient was forced to fall

out. After a short rest he returned to the drill, but the pain persisted. A few minutes later he experienced a sudden sharp pain in the lower third of the leg, heard a loud snap, and fell to the ground, unable to walk.

Roentgenograms of the right leg (Fig. 6) revealed an oblique, complete fracture through the tibia in its distal third. The position was excellent. The leg was placed in a plaster cast. Recovery was uneventful.

*Comment:* The extent of the fracture in this case is far greater than in any of the three preceding cases, being of such extent as to cast doubt on the diagnosis of "march fracture." The patient, however, is emphatic in his statement that he did not twist his leg in any manner. The gradual onset of the pain, the progressive severity, and the definite relation to marching and weight-bearing also indicate that this is a fracture associated with marching. It is possible that the fracture was at first incomplete, and was due to continued marching, but that torque supplied by a minor twist of the leg was sufficient to convert it into the form seen in Figure 6.

#### SUMMARY

Attention has been called to the fact that march fractures may occur in the tibia. These fractures will probably be seen in increasing frequency in the armed forces. The fracture line is usually quite narrow and must be sought carefully. Callus formation is seen early. The history is quite similar to that obtained in march fractures of the metatarsals, varying only in the site of pain. Four cases are reported.

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# March Fracture of the Inferior Pubic Ramus:

## A Report of Three Cases<sup>1</sup>

MAJOR DEAN B. JONES, M.C., A.U.S.

AT ALL ARMY POSTS there have developed considerable interest in, and speculation about, the nature of march fractures. Three cases involving the inferior pubic ramus are being recorded here which have been characterized by absence of any history of trauma, absence of any other break in the pubic ring, and roentgenographic findings believed to be indicative of march fracture. These same cases are included in a comprehensive study of "March Fractures" to be published by the Chief of the Orthopedic Section of this hospital, in another journal.

### CASE REPORTS

**CASE 1:** An infantryman, aged 34 years, had been in service approximately three and a half months. He had been engaged in simulated combat maneuvers and during this rather strenuous activity began to experience some pain along the adductor aspect of the left thigh. There was no history of trauma; rather one of slow insidious development. About six weeks after onset the pain radiated as far as the perineal region, and the patient came to the Clinic for examination. A course of physiotherapy was prescribed, but he failed to improve and further examination revealed marked tenderness close to the pubic bone. Roentgenograms revealed a rather broad hazy line of decreased density traversing the left inferior pubic ramus, in a vertical direction, with an area of periosteal proliferation at its proximal extremity close to the periphery of the obturator foramen (Fig. 1). No other break in the pubic ring was present. The patient was hospitalized and made a complete symptomatic recovery with simple bed rest.

**CASE 2:** An infantryman, aged 25, came to the Clinic complaining of pain along the adductor aspect of the right thigh. As in Case 1, the onset was insidious and could not be related to any acute traumatic incident, nor was there any response to a regimen of physiotherapy. Roentgenograms again showed a zone of rarefaction and surrounding periosteal reaction in the region of the mid-portion of the inferior ramus of the pubis, at the site of origin of the adductors (Figs. 2 and 3). The patient made a satisfactory recovery following simple bed rest.

<sup>1</sup> From the Department of Roentgenology, Station Hospital, Camp Maxey, Texas. Accepted for publication in July 1943.

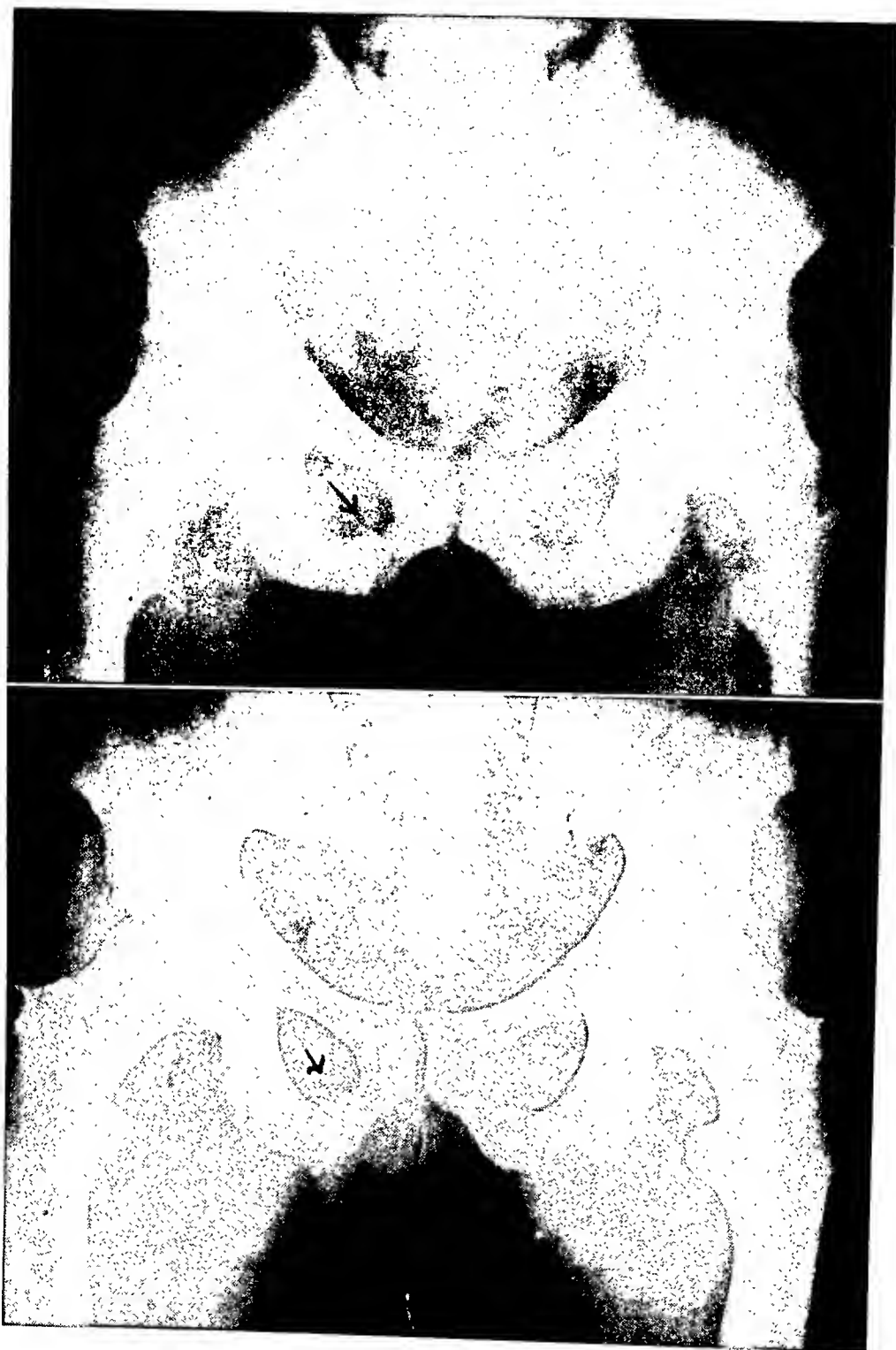


Fig. 1. Case 1: Roentgenogram showing broad hazy line of decreased density transversing the left inferior pubic ramus.

**CASE 3:** This case was similar in all essential respects to the other two. A soldier, aged 26, who gave no history of trauma to the pubis or any portion of the pelvis, complained of pain in the adductor region. Roentgenograms of the pelvis revealed a later stage of the previously described process with productive change in the region of the inferior ramus, replacing to some extent the rarefaction which was prominent in the earlier cases (Fig. 4).

### COMMENT

Three cases are presented showing rarefaction across the inferior ramus of the pubis with a zone of periosteal proliferation at the margins, the periosteal reaction being most prominent on the upper margin of the ramus. The only case previously discovered in a superficial survey of the literature is that of Wilhelm (2), in which the roentgen appearance was, in all respects, comparable to that in the cases reported here. This case appeared in the German literature, and was discovered in a member of the German Army before our relations became less cordial. The author stated that these and all "march" or "insidious" fractures occurred in young men of previous sedentary existence who were suddenly introduced into rigorous



Figs. 2 and 3. Case 2: Fracture of right inferior pubic ramus. The lower roentgenogram was made some time after the upper.





Fig. 4. Case 3: Fracture of left inferior pubic ramus first observed in a later stage than Cases 1 and 2.

military training. The fractures occurred in the young trainees and not in the older, trained and conditioned soldiers. These criteria were present in our cases also.

Brandt (3), also in the German litera-

ture, though not describing this particular fracture, states that these lesions occur "insidiously as result of rhythmically repeated, subthreshold, mechanical insults, which only by summation lead to structural changes and severance of continuity." He lists the following synonyms: "transformation zones, callous tumors, fractureless callus, overload injuries, exhaustion fractures, and insufficiency diseases."

The main practical point to be kept in mind, especially by the Army orthopedist and roentgenologist, is that in the presence of adductor, hip, or pelvic pain, a check by roentgenogram of the pelvis should be a part of the examination. We feel sure this condition will be found frequently in the Armed Forces, if it is frequently sought.

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# Basilar Impression: The Position of the Normal Odontoid<sup>1</sup>

WM. W. SAUNDERS, M.D.

San Francisco, Calif.

IN 1939 W. E. CHAMBERLAIN (1) called attention to the syndrome of basilar impression, which had been described in the European literature (2-4) years before. The syndrome includes symptoms mimicking syringomyelia, progressive spastic paralysis, or multiple sclerosis in the region of the upper cervical cord and medulla, and a shortening of the neck. The roentgenogram shows deformities of the foramen magnum and anomalies of the base of the skull, the atlas, and axis, sometimes including fusion of the bodies of some of the upper cervical vertebrae, and often fusion of the anterior arch of the atlas to the occipital bone. Since 1939 enough additional cases have been reported to indicate that the condition is not excessively rare. The symptoms can often be relieved by surgery. It becomes a matter of some importance, therefore, to set up proper diagnostic criteria.

Chamberlain points out that the final diagnosis must usually be made by the radiologist on the basis of changes in the relations at the base of the skull, including displacement of the atlas and the tip of the odontoid above their normal position, which he states is entirely below a line joining the posterior margin of the hard palate with the dorsal margin of the foramen magnum.

This dictum has been used as an important criterion, notably by Walsh, Camp, and Craig (5) and by Laube and Turner (6). The former authors have christened the determining line the "Chamberlain line." Before this criterion is finally accepted, however, the range of position of the tip of the odontoid in the lateral roentgenogram of normal persons needs to be established.

Since basilar impression is so rare, the general run of patients having skull examinations may be considered normal in this respect and can properly be used as controls. We have chosen from among our latest examinations 100 lateral skull films

TABLE I: POSITION OF THE TIP OF THE ODONTOID WITH RESPECT TO "CHAMBERLAIN'S LINE" IN 100 NORMAL PERSONS

Mm.	No. of Cases	Mm.	No. of Cases
+8 (above)	1	-2 (below)	10
+7	1	-3	7
+6	0	-4	8
+5	3	-5	6
+4	5	-6	5
+3	8	-7	2
+2	8	-8	2
+1	9	-9	0
0	13	-10	1
-1 (below)	10	-11	1

Note: Direct measurement from films. Anode-film distance 36 inches.

on which no roentgen diagnosis of disease could be made. In none of these cases were there symptoms at all suggestive of the syndrome of basilar impression. The position of the tip of the odontoid process was carefully measured with respect to a line joining the dorsal margin of the hard palate with the dorsal margin of the foramen magnum. Table I gives the results arranged by 1-mm. intervals, the minus sign indicating that the tip of the odontoid lies below the reference line and the plus sign above.

The arithmetical mean position of the top of the odontoid in the normal roentgenogram is, therefore, about 1 mm. (0.94) below the reference line. The standard deviation is 3.6 mm. The normal probability curve corresponding to these coordinates is seen to lie close to the plot of the crude data. One may then use the normal curve to calculate the probability that the tip of the odontoid will lie above

<sup>1</sup> From the Division of Radiology, Stanford University School of Medicine. Accepted for publication in February 1943.

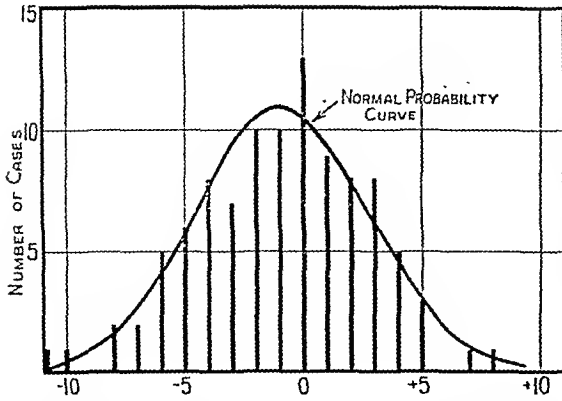


Fig. 1. Position of the tip of the odontoid in 100 normal skull roentgenograms: millimeters above (+) or below (-) the hard palate-foramen magnum line.

the reference line by varying amounts, as follows:

- 1 in 5 will lie more than 2 mm. above the line.
- 1 in 19 will lie more than 5 mm. above the line.
- 1 in 64 will lie more than 7 mm. above the line.
- 1 in 800 will lie more than 10 mm. above the line.

#### CONCLUSIONS

1. The average position of the tip of the odontoid in the normal lateral skull film is 1 mm. below "Chamberlain's line."
2. Only reasonably large deviations above the line are significant of abnormality. A smaller deviation should suggest the possibility of basilar impression

and should call for special examination of the foramen magnum, when necessary, to make the diagnosis.

#### SUMMARY

The position of the tip of the odontoid on 100 lateral skull films of "normal" patients was found to be 1 mm. below a line from the dorsum of the hard palate to the dorsum of the foramen magnum, with a standard deviation of 3.6 mm.

*Acknowledgment:* I wish to thank Dr. R. R. Newell for his encouragement and advice and Dr. Sydney F. Thomas for his active assistance.

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# EDITORIAL

Howard P. Doub, M.D., Editor

John D. Camp, M.D., Associate Editor

## The Palliative Point of View about Cancer

The existent attitude of the laity and of many physicians toward the control and cure of cancer apparently is an unaltered relic of medieval superstition. The conception of cancer as an incurable disease is widely accepted by many people, including not a few physicians, in spite of the laudable educational efforts of the American Society for the Control of Cancer and other organizations toward dispelling this belief. It is true that some individual cancers are incurable and the hopelessness in the given case may be recognized and pronounced by the physician at the initial examination, yet the published figures of thousands of cancer cures should exert an influence in changing this point of view toward cancer as a whole, even with the most dismal pessimist.

The diagnosis of arteriosclerosis, chronic nephritis, diabetes mellitus, myocarditis, coronary vascular disease, osteitis deformans, and many other degenerative conditions is accepted with equanimity, fortitude, and optimism by the majority of patients, and yet in the category of end-results of treatment they are all *incurable* diseases. Even in cases of tuberculosis or of pernicious anemia, one refers to an arrest rather than to a cure. When confronted with one of these incurable conditions in his own person, the patient asks of his physician only that treatment which lies within the realm of possibility, hoping that it will successfully arrest the process for the time being, avoid the complications and disabilities attendant on the disease, and prolong his life in comfort. Not so is the attitude of the same patient and his family if the diagnosis be cancer as,

in this event, nothing short of a guarantee of cure seems to suffice. An expression by the physician of a reasonable doubt concerning an ultimate cure or a statement covering the statistical chances (if less than 100 per cent) frequently leads to a profound and unreasonable reaction, in which a decision is made to refuse all treatment, surgical or radiological. In other words, palliative treatment is eagerly accepted for all incurable diseases except cancer; its employment for cancer is generally regarded with skepticism and without enthusiasm. In the eyes of the family, the patient is practically dead the moment a pronouncement of incurability is made.

The medical profession has not been faultless in this regard. The accent has constantly been on cure rather than palliation; naturally this is a commendable effort. Published figures on the end-results of treatment from institutions, surgeons, and radiologists specializing in cancer therapy, usually present as the culmination or reward for their efforts, the percentages of so-called five-year cures, or survivals without recurrence for five years. Such figures may vary from 10 to 90 per cent of the cancers treated, depending on the regions involved, stage of the disease, histological types, etc. The reader accepts this figure as the sole expression of life salvage in the group of patients studied. If an economist were to analyze the same data, he would undoubtedly devote some attention to the great group of cases, which are usually summarily dismissed from consideration as failures of cure. This analysis would bring to light and properly accredit the palliative benefits

derived in the short-term (less than five-year) survivors.

If radiological and surgical treatments do prolong the lives of incurable cancer patients, there should be some means of expressing the advantage in a statistical manner, and such results should be duly published. Only in such a way can comparable results of palliative treatment be properly evaluated and improved. One method is to determine, for each regional variety of cancer, the average length of life without treatment, from the time of onset of symptoms to death. Daland and Nathanson have done this for cancer of the breast, and the figures they have provided for the percentages of patients living without treatment for one, two, three, four, and five years can be plotted in a curve, which constitutes a "natural yardstick" against which the cancer therapist can plot the results of palliative treatment of breast cancer. Similar yardsticks for measurement of the average duration of life without treatment should be plotted for cancers of all regions and organs. The general acceptance of such tables would afford all hospitals and physicians treating cancer an opportunity to determine the palliative value of any treatment they are wont to use.

The prolongation of life itself is, of course, not the only measure of palliation. No one wishes to live longer in order to suffer more. The indications for palliative efforts are the relief of pain and discomfort, the healing of ulcerated lesions, the lessening of hemorrhage and infection, the repair of certain pathological fractures, the healing of metastases in bone, the eradication of cough and dyspnea, the

restitution of sleep, the delay in generalization of the cancer, and many other well known and admitted benefits of treatment chiefly by radiation methods. It is possible that well judged and appropriate irradiation, for example, might accomplish one or all of the above enumerated benefits without prolonging the life of the individual, yet who would deny that such efforts are worthwhile.

Surgical measures which have been employed for palliative purposes are resection of offensive cancers which are infected, foul, bleeding, or obstructed, the abolition of pain by the severance of sensory nerve tracts or by the injection of alcohol into proper nerves, and the relief of obstruction by short-circuiting operations chiefly on the gastro-intestinal and urological systems. Radiologists have an even greater scope for their palliative efforts in the use of x-rays and radium, the only known agents to effect the cure and palliative relief of cancer with the preservation of the tissues which contain the cancer. Surgery may divorce the patient from his cancer, but does so by amputating a member or removing a part or a whole of the organ involved, providing the organ is not essential to life and the cancer has not disseminated. Strictly speaking, the ideal cure is the destruction of the cancer with preservation of the host tissues, and radiation therapy is the nearest, in fact the only method devised to date which approaches this principle. Radiologists should report the results of radiation therapy not only in the cure of cancer, but in palliative relief, in which field they have little competition.

GEORGE T. PACK, M.D.



## ANNOUNCEMENTS AND BOOK REVIEWS

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### DALLAS-FORT WORTH ROENTGEN CLUB

The recently organized Dallas-Fort Worth Roentgen Club extends a cordial invitation to all radiologists, especially those who are located at nearby Army Camps, to attend its meetings. The meetings, which are held on the third Monday of each month, are strictly informal, being preceded by dinner at 7:30. General problems of interest to radiologists are discussed and films of interest are shown. The Club meets in Dallas in the odd months and in Fort Worth in the even months of the year.

Dr. J. R. Maxfield, Jr. (Medical Arts Building, Dallas), president of the Club, or Dr. X. R. Hyde (Medical Arts Building, Fort Worth) will be glad to furnish information regarding the meetings to anyone who may be interested.

### Books Received

THE 1943 YEAR BOOK OF RADIOLOGY. Diagnosis edited by CHARLES A. WATERS, M.D., Associate in Roentgenology, Johns Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital, and WHITMER B. FIROR, M.D., Assistant in Roentgenology, Johns Hopkins Uni-

versity; Assistant in Roentgenology, Johns Hopkins Hospital. Therapeutics edited by IRA I. KAPLAN, B.Sc., M.D., Director, Radiation Therapy Department, Bellevue Hospital, New York City; Associate Radiologist, Lenox Hill Hospital, New York City; Clinical Professor of Surgery, New York University Medical College. 456 pages and 378 illustrations. Published by The Year Book Publishers, Inc., Chicago, Ill., 1943. Price \$5.00.

### In Memoriam

JOHN A. HERRING, M.D.  
1891-1943

Dr. John A. Herring of St. Petersburg, Florida, died after a brief illness on Nov. 17. Doctor Herring was born in Georgetown, Ky. He was a graduate of the Medical School of the University of Michigan and served his internship in St. Luke's Hospital, New York. After teaching for a brief period in Cornell University and in the University of Michigan, he specialized in roentgenology. Since 1925 he had practised in St. Petersburg, serving on the staffs of Mound Park and St. Anthony's Hospitals. He was a member of the Radiological Society of North America.



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## ROENTGEN DIAGNOSIS

### THE HEAD AND NECK

The Cranial Serigraph and Its Utility in Neurologic Radiology for Cerebral Angiography. J. M. Sanchez-Perez. *Surgery* 13: 661-666, May 1943.

The author has in previous communications described the method of making complete cerebral angiograms by means of the "escamoteador," originally conceived by Egas Moniz. He has himself devised a new portable apparatus, adapted to any x-ray table and much easier to handle. This apparatus, which he calls a serigraph, is constructed for use with  $10 \times 12$ -in. films. It consists of a box  $15 \times 12.5 \times 4$  in. containing vertical steel springs and a platform accommodating three identical trays or cassette carriers one above the other, each containing a thin sheet of lead for protection of the underlying films. The cover of the box has on its superior surface a Lysholm grid. A lead-lined compartment is provided for receiving the cassettes after exposure.

The serigraph is placed at one end of the x-ray table, the tube is centered at a distance of 40 inches so that the central rays will pass through the center of the films, and the patient is placed on the table in the supine position with the head resting on the box. After exposure of the common carotid artery, 6 c.c. of radiopaque substance (diodrast or thorium dioxide) is injected and at the instant the injection is complete the initial film is exposed. This is the arteriogram. The first tray and its cassette are then removed and after one and one-half seconds the second film is exposed. This is a "phlebogram of the first phase." After a lapse of another second and a half the third exposure is made, the "phlebogram of the second phase."

The author cites briefly three cases to illustrate the importance of complete angiography. In the first a huge aneurysm of the internal carotid was demonstrable on the arteriogram only. In the second the arteriogram was difficult to interpret but the phlebogram of the first phase (the second film) showed clearly a shadow indicating a metastatic cerebral tumor, confirmed at necropsy. In the third case a meningioma was shown only in the second phase phlebogram.

J. E. WHITELEATHER, M.D.

Paraphysial Cysts of the Third Ventricle: Diagnosis and Surgical Management. Laurence M. Weinberger and Benjamin Boshes. *Surgery* 13: 368-384, March 1943.

The authors have found in the literature sixteen accounts of paraphysial cysts successfully removed. They present the significant details of these cases in tabular form, add a seventeenth example, and review the diagnostic and surgical methods which have been employed.

Their patient was a 22-year-old woman who had been entirely well until approximately three weeks before admission, when she was awakened one morning by an agonizing headache followed by vomiting. The headache gradually disappeared but recurred each succeeding day. It involved mainly the frontal and occipital areas and was described as "pushing" or "pressing." It was intensified in the supine position. Shortly before admission the patient began to ex-

perience attacks of pain in the back of the neck, radiating down into the shoulders and arms and accompanied by numbness of the hands. Finally double vision developed. Examination revealed palsy of both external recti muscles, bilateral papilledema, and flame-shaped retinal hemorrhages. The visual fields were full; visual acuity was 20/30. Ventriculography showed dilatation of both lateral ventricles, especially the left. The third ventricle was not demonstrable in any position. The air shadows in both lateral ventricles were sharply cut off. A diagnosis of tumor occupying the anterior portion of the third ventricle was made.

At operation, performed as an emergency measure, the foramen of Monro was found to be collapsed. At its orifice appeared a glistening tumor, which was grasped by a forceps and slipped through the foramen into the third ventricle. The tumor was the size of a small cherry and appeared to be a thin-walled translucent cyst with fine vessels traversing the surface. It was separated from the choroid plexus to which it was attached and was removed. The septum lucidum was punctured to insure drainage from the right to the left ventricle and a Penrose drain was placed within the lateral ventricle and brought out through the dural flap. At the end of four months the patient had almost fully recovered. The visual acuity was 20/20, visual fields were full, there was no optic atrophy, and neurological examination was negative except for a slight weakness at the left angle of the mouth.

Paraphysial cysts are now recognized as arising from the paraphysial body, an ancient gland situated in the mid-line of the rostral portion of the roof of the third ventricle. It is found in all vertebrates and in the human embryo appears on about the seventy-fifth day of gestation and disappears shortly thereafter. In some persons, remnants of the gland apparently persist throughout fetal life and presumably enlarge slowly during postnatal existence by retention of the products of the secreting epithelial cells. If growth continues, the cyst enlarges until it occupies and fills the anterior portion of the third ventricle, eventually obstructing the intraventricular foramina. Both foramina are likely to be blocked equally, resulting in a dilatation of the lateral ventricles, which is generally symmetrical. Gradual dilatation from an incomplete block may occur and yet cause no symptoms. The onset of violent headache, vomiting, and papilledema occurs when the block becomes complete. Impaction of the tumor into one or both foramina may occur for transient periods, marked by episodes of increased intracranial hypertension, which may subside abruptly. The explanation of this curious phenomenon is that there is a certain degree of mobility to these pendulous tumors which hang from the roof of the third ventricle. A change in position may dislodge the tumor enough to obstruct the foramina suddenly and completely. Venostatic edema of the basal ganglia as well as an increased secretion of fluid due to the raised venous pressure in the plexus may result from compression of the lesser veins of Galen in the foramina. Sudden death is not an uncommon ending to these episodes.

Not only is a syndrome diagnostic of these tumors lacking but a review of the literature reveals that they may exist without producing evidence of intra-

cranial hypertension, although they cause other onius symptoms. Slowly progressive dementia, a chronic convulsive state, primary optic atrophy, and other symptoms not ordinarily ascribed to intracranial pressure may comprise the clinical picture.

Histories of cases show so many vagaries that little is obtained for diagnostic purposes from a study of the records. The first manifestations may announce themselves with apoplectiform rapidly, sudden coma, and death. On the other hand, evidence of what appears to be diffuse degeneration of the nervous system may exist for years. Diagnosis rests upon evidence afforded by pneumography.

The pneumographic findings vary somewhat, depending upon the completeness of the intraventricular foraminal block and the integrity of the septum lucidum, the type of air study, and whether one or both ventricles are punctured in the performance of ventriculography. Encephalography is, in the opinion of most neurosurgeons, hazardous. If both the lateral ventricles are cannulated a characteristic ventriculogram is obtained, both the ventricles appear dilated, and no air is seen within the third ventricle in any position. The foramina of Monro are dilated. Occasionally the outline of the tumor may be seen bulging into one or both lateral ventricles. If only one lateral ventricle is cannulated and the septum lucidum is intact, only one ventricle will show. If the septum is frayed or torn, the air may pass through and both ventricles will fill. Since either of these observations may lead to misinterpretation, the authors favor injection of both ventricles with air at the same time.

Operation should be undertaken when the ventriculographic diagnosis is made, as disaster may otherwise occur. Many approaches have been made, but the author favors a transcortical route, which is deemed less hazardous than the transeallosal route. Since the tumors lie exactly in the mid-line there is no occasion for an approach from the left, which may produce aphasic disturbances or defects in spatial orientation. The author believes the operation should be performed in one stage. Ample working room is usually obtained within the dilated lateral ventricle; the structures are seen clearly, and the foramen of Monro may be found promptly by following the choroid plexus forward until it disappears. The cyst, if large, presents itself as a greenish or bluish mass in a dilated foramen. If small, it may not be visible and the foramen may appear as a small slit. By tugging gently on the choroid plexus, the cyst wall can be brought into view in the aperture of the foramen and then grasped with an instrument. Some operators have first evacuated the contents of the cyst by aspiration and others have enlarged the foramen by slitting the margin. The slit can be made safely only in the anterior rim of the foramen, which is formed by the descending pillars of the fornix.

Since manipulations around the foramen may produce edema and thus obstruct the drainage of the ventricles, it is worth while to take the precaution of opening the septum lucidum, if an opening is not already present. Drainage for a few days may prevent cerebral swelling and remove blood and detritus from the ventricle. If the incision through the cortex is placed well anterior to the motor strip, complete recovery should follow operation, since removal of the tumor ordinarily entails no trauma to vital structures.

J. E. WHITELEATHER, M.D.

Case of Associated Facial and Intracranial Hemangioma. L. B. Shapiro. Illinois M. J. 83: 272-274, April 1943.

A case of associated facial and intracranial hemangioma is presented. The clinical findings were a left-sided facial nevus, localized jacksonian convulsive seizures involving the right lower extremity, urinary incontinence, and roentgen evidences of calcification in the occipital cortex.

The author prefaces his report with a review of the literature. Greenwald and Koota (Am. J. Dis. Children 51: 868, 1936) in a survey of 81 published cases found convulsive seizures, generally jacksonian in type, hemiplegia, mental retardation, and ocular changes to be the outstanding symptoms. Thirty-four of their 81 collected cases were studied roentgenologically. X-rays of the skull revealed a characteristic shadow that had a double contour and in some cases seemed to follow the outline of the gyri and sulci of the cortex. In most of the cases, the shadows appeared to be in the region of the occipital lobe. Some showed atrophy of the brain and marked increase in vascularization.

HENRY K. TAYLOR, M.D.

Sialolithiasis in Infancy. T. Valledor, A. Codinaeh, and L. Expósito. Bol. Soc. cubana de pediat. 14: 603-616, December 1942.

A case of sialolithiasis in a 10-year-old girl is reported. It is believed that the formation of the calculi began at the age of eighteen months. The right parotid gland, site of the calculi, was large and hard and had been so for about eight years, the condition having been diagnosed at various times as a parotid tumor. Roentgenograms revealed the calculi, which were removed through a buccal incision. They were thirteen in number, varying in size from bird shot to a large pea. They were composed of calcium carbonate and all those examined proved to be bacteriologically sterile.

Although relatively common in the adult, parotid calculi are rare in infancy.

A. MAYORAL, M.D.

Myeloma of the Maxilla with Bilateral Symmetrical Metastasis. Carlos E. Gárciga. Rev. med. cubana 53: 794-800, September 1942.

A 6-year-old boy had a tumor of the jaw with bilateral metastases in the knees. The clinical as well as the radiological diagnosis was osteosarcoma, but because of the extreme sensitivity of the maxillary lesion to radiation the writer became suspicious and requested a biopsy. This revealed the tumor to be a myeloma.

A. MAYORAL, M.D.

Roentgenologic Examination of the Pharynx. Siegfried W. Westing. Am. J. Roentgenol. 49: 587-592, May 1943.

Whenever the roentgenologist is performing an opaque meal examination of the alimentary tract, he has an opportunity to examine the lower half of the pharynx, but this opportunity is frequently neglected. The short duration of the filling of the normal pharynx makes it difficult to obtain roentgenograms of that area, and this being the case, the role of roentgenoscopy becomes more important. One should make it a rule to return to this region after the study of the stomach is completed. In the postero-anterior projection the width of the pharynx is determined by the distance

between the lateral walls of the piriform sinuses. The chief characteristic of this view is the completely symmetrical appearance of the barium stream. Even slight asymmetries may be of diagnostic significance. After the bulk of the barium has left the pharynx, small residues normally remain for a short period in the valleculae and piriform sinuses. Lateral and oblique observations are also made.

Roentgenograms are reproduced showing the normal pharynx and abnormal filling due to the presence of carcinoma. One of the carcinoma patients did not have the characteristic history of dysphagia. As symptoms may be lacking in such conditions, it is especially important that this area be scrutinized carefully on roentgenoscopic examination with the barium meal.

CLARENCE E. WEAVER, M.D.

### THE CHEST

Discussion on the Place of Miniature Radiography in the Diagnosis of Diseases of the Chest. W. D. W. Brooks *et al.* Proc. Roy. Soc. Med. 36: 155-160, February 1943.

This discussion was opened by Surgeon Captain W. D. W. Brooks, R.N.V.R., who stated that fluorographic examinations were introduced into the British Royal Navy in the spring of 1940, to include the entire service. Up to July 1942, 166,598 men were examined. Among these there were revealed 1,370 cases (8.2 per 1,000) of pulmonary tuberculosis of adult type: 498 minimal, 584 moderately advanced, and 288 far advanced. In addition there were found 27 cases of active primary tuberculosis, 3 of chronic military tuberculosis, 35 of pleurisy with effusion, 3 of tuberculous empyema, and 1 of spinal caries of tuberculous origin. Many other lesions affecting the thoracic cage and its contents were also discovered. During the third quarter of 1942 an additional 50,000 men were examined, and the incidence of tuberculosis in this group was slightly higher. Two cases of bronchial carcinoma were found in the 217,000 examinations.

The fluorographic examination is used only to detect the presence of disease. When it is demonstrated, the usual routine examinations and clinical studies are made for diagnosis. Experience has confirmed the wisdom of this practice.

Major J. Duncan White refers to the experience with fluorography in the British Army and mentions a survey by Major Kerley, covering some 5,000 men and showing results similar to those given by observers in the other services. He mentions the use of 4 X 5-in. films in the U. S. Army; compulsory periodic fluorographic examination of the chest for all persons over 15 years of age in Norway, under German domination; and the incidence of unsuspected tuberculosis (1.5 per cent) found in 2 million fluorographic examinations in Germany. He believes that mass chest surveys are a vital step in the direction of the earlier detection of pulmonary tuberculosis and agrees with Brooks that the method is not to be condemned because a few minimal lesions may be missed, and that the correct procedure in any case in which the fluorograph is suspicious is re-examination with a full-size roentgenogram. Rechecks will vary from 3 to 5 per cent. The greater the experience with fluorographs, the fewer rechecks will be required.

White quotes Crawford's observations in a group of 300 men discharged from the Army for pulmonary

tuberculosis (Lancet 2: 89, 1942). The lesions were described as minimal in 24 per cent, moderately advanced in 66 per cent, and advanced in 10 per cent. These men had been passed recently by recruiting men, but were not submitted to x-ray examination. At least three-fourths of the number would have been rejected for service had a fluorographic examination been available at the time of or soon after enlistment.

Wing Commander R. R. Trail concluded the discussion. He stated that for every 1,000 examined, 35 to 40 will require re-examination with large films, 20 will require clinical examination, 8 will show disease, and 3 will require hospitalization. A static unit could make between 75,000 and 100,000 examinations a year. He would like to see mass surveys on a national scale.

HENRY K. TAYLOR, M.D.

Incidence of Pulmonary Tuberculosis of the Adult Type in the R.A.F.: Results of Mass Radiography of 75,000 Cases. A. G. Evans. Brit. M. J. 1: 565-566, May 8, 1943.

The author offers an analysis of age incidence of pulmonary tuberculosis of the adult type and discusses problems which will arise in the future when mass radiography becomes the natural undertaking. Statistics are presented which are based on mass examination of active cases, for the most part among airmen. Some of these showed unilateral tuberculosis while others had bilateral infections. Sets of figures are also presented based on mass examination of the W.A.A.F. organization.

The criterion of activity is a strict one. Every patient suspected of tuberculosis had a full-sized roentgenogram with complete clinical examination including blood sediment, sputum, and exercise tests. It is interesting to note that 28 per cent of the people one time considered "fit" had actually reached the stage of cavity formation at the time of examination, which fact presents an important bearing on radiographic examination. Approximately 2 "bad" cases for each thousand examined were discovered and the opinion is expressed that this percentage would be definitely higher in civilian groups.

Routines of observation are presented and it is suggested that in the young age groups a roentgenogram should be made twice yearly for the first two years and then annually for the following three years. The author seems to be of the opinion that mass radiography is of great importance in discovery of advanced cases, which are a serious source of spread of infection.

Q. B. CORAY, M.D.

The Round Pulmonary Tuberculous Focus. I. D. Bobrowitz. Am. Rev. Tuberc. 47: 472-483, May 1943.

This study of the round pulmonary tuberculous focus is based on a series of 55 patients. In 33 of these the focus was present when the patient was first seen, while in 7 others it appeared on subsequent examination, either in areas of previously normal lung or in areas where there had been infiltration. In 7 patients spontaneous closure of a pulmonary cavity resulted in a round focus and in 8 others round foci were formed by the closure of cavities as a result of pneumothorax. Of those patients with a round focus demonstrable at the original examination, the majority showed stability of the foci on subsequent examination.

Many ideas have been presented to explain this particular type of pulmonary infiltration. From the

study of the cases presented, the author is of the opinion that these foci are the end-result of tuberculous cavitation. He found nothing to suggest that they resulted from a primary infection, but all of the evidence seems to point to a relationship with previous cavitation. The round focus, however, represents only one form of cavity closure.

At necropsy, these foci have been shown to be spherical bodies of thick, caseo-calcified structureless material enclosed in a dense connective-tissue or hyalinized capsule of varied width. It is pointed out that, though this type of lesion is usually benign, it is capable of progression even after long periods of time and should be carefully followed. An increase in the size of the focus often precedes actual cavitation or progression and is an indication for collapse therapy, the type depending upon individual variation. Bed rest alone does not promise the immediate control of the lesion that is required.

L. W. PAUL, M.D.

**Chest Conditions Simulating Tuberculosis.** E. R. Crow. *Minnesota Med.* 26: 430-436, May 1943.

Crow's observations are based on cases with which he has come in contact in the course of his work in the Minnesota State Sanatorium.

**Acute Pneumonia:** Lobar pneumonia in children, which of the exudative type, may simulate the primary infection of tuberculosis. The time required for clearing is of value in the differential diagnosis. A case is cited in which tuberculosis was ruled out by clearing in a period of two weeks, in spite of a positive Mantoux reaction. In adults bronchopneumonia may cause confusion.

**Silicosis:** The principal diagnostic features in silicosis are enlargement and increased density of the hilar nodes, bilateral lower and mid-lung areas of linear density radiating from the hilus, and the presence of silicotic nodules. There are no shadows of annular type suggestive of the cavities seen in tuberculosis. Serial roentgenograms made over long periods of time show little change in the picture. It is to be borne in mind, however, that tuberculosis may complicate silicosis.

**Pulmonary Abscess:** Abscesses are usually unilateral, occurring in the lower or mid-lung field. Roentgenographically they appear as dense, circumscribed areas, thick-walled, and usually containing fluid. Bronchograms may be of aid in diagnosis. The evaluation of the Mantoux test here, as in other conditions, depends upon the age of the patient and other factors.

**Bronchiectasis:** In bronchiectasis the history is often that of long-continued cough and expectoration and recurring episodes of respiratory infection. Bronchography is usually diagnostic, though plain films often suggest bronchial dilatation. In a roentgenogram reproduced in this connection fan-like linear shadows are seen radiating from the hilus downward to the lower lobes. Films may show in addition such associated conditions as atelectasis, abscess, bronchial tumor, abnormalities of the cardiac shadow, and foreign bodies.

**Carcinoma:** In carcinoma pain and dyspnea are more prominent symptoms than in tuberculosis. The x-ray is of great value in differentiation. While both diseases show a predilection for the upper lobes, carcinoma usually spares the apices and originates in the hilus. Partial or complete atelectasis of an area without lesions suspicious of tuberculosis elsewhere in

the lung is suggestive of carcinoma. Such areas are in fact usually the first x-ray evidence of tumor, being due to obstruction of the bronchus in this area. Sputum examination, bronchography, and bronchoscopy all are of importance diagnostically.

**Other Conditions:** Less difficulty is experienced in excluding chronic passive congestion, postoperative atelectasis, and the other conditions in which thickening of the linear lung markings or the production of infiltrative areas may occur. The author reports one case in which he feels that a diagnosis of syphilitic pulmonary involvement of diffuse type was justified.

PERCY J. DELANO, M.D.

**Imitation of Pulmonary Tuberculosis by Acute and Chronic Congestion in Cases of Mitral Stenosis.** Albert Alder. *Schweiz. med. Wchnschr.* 73: 530-532, May 1, 1943.

The author reports two cases of mitral stenosis in which hilar enlargement and increased perihilar markings simulated roentgenographically a recent tuberculous infiltrate. Both cases went on to pulmonary edema, roentgenologically confirmed, and in neither was tuberculosis ever proved.

The first patient had numbers of pulmonary calcifications, which the author ascribes to chronic stasis. However, a positive tuberculin reaction was obtained and no autopsy is reported (the patient being apparently still living when the article was written), so that this conclusion may be open to question. In the second patient the roentgenogram showed numerous fine nodulations similar in appearance to miliary tuberculosis. These also were believed to be solely the result of stasis. Such findings may lead to an erroneous diagnosis of hematogenous dissemination.

LEWIS G. JACOBS, M.D.

**Primary Friedländer Pneumonia.** L. Hyde and B. Hyde. *Am. J. M. Sc.* 205: 660-675, May 1943.

This report is based on 51 cases of Friedländer pneumonia. Acute and chronic cases are here considered together, since there were no significant differences in age, sex, or seasonal incidence, type of organism, lobes involved, or symptoms.

The thick capsules of the short, gram-negative, non-motile, non-sporing rods are easily stained. The mucoid, or smooth, colony is the type most important clinically. The soluble specific substances of *B. friedländer*, type B, and of *Pneumococcus* type II are closely related chemically and serologically, since serum of one will protect mice against infection by the other. The bacilli have been isolated from the respiratory tract, stools, urine, bile, meninges, vagina, and uterus.

Friedländer pneumonia is most likely to be found in males over forty. Over half the cases in the authors' series had their onset between November and April. Debilitating factors are important, but the disease usually develops suddenly in previously healthy persons. The reported incidence of this type of pneumonia is low, ranging from 0.5 to 5.0 per cent. The range of incidence in the normal upper respiratory tract varies with different reports from less than 1 to 5.8 per cent.

When death occurs in the acute phase, the lungs are large, heavy, firm, bright red in color, with thick, gelatinous, tenacious, reddish-gray alveolar exudate. The pleura over the involved lobes is covered with a heavy fibrinous exudate. In less than half the cases

many small (1 to 6 mm.) abscesses can be seen. Microscopically the alveoli are filled with a serous or cellular exudate. In more cellular areas there is usually a fibrinous meshwork. The alveolar septa are destroyed and there are areas of alveolar hemorrhage. The interlobar and interacinar septa are thickened and greatly enlarged.

The main process in the chronic phase is parenchymal destruction with abscess formation. One or more large cavities may be present. Empyema, pericarditis, meningitis, and not uncommonly fatty liver and portal cirrhosis may be found.

The onset, as with lobar pneumonia, is usually sudden, with cough, sputum, chest pain, and chills. The admission diagnosis is usually lobar pneumonia. The temperature elevation, pulse, and respiratory rates are not different from those of lobar pneumonia. About 30 per cent of the patients have a leukocyte count of 11,000 or below. The physical signs are also those of lobar pneumonia.

During the acute phase the predominant roentgenographic finding is a massive dense homogeneous shadow, frequently suggesting fluid. In about one-third of the cases (the group entering the chronic phase) there is a sequence of primary bronchopneumonia, secondary pseudolobar confluence, necrosis with formation of multiple thin-walled abscesses, and the stage of fibrosis and healing.

Bacteremia, when it occurs, is usually slight quantitatively, but the mortality rate among the bacteremic patients is higher than for those without bacteremia.

Acute primary Friedländer pneumonia may lead to early death (one-half of the cases), fairly prompt recovery with resolution (one-sixth of the cases), or necrosis and abscess formation (chronic phase, in one-third of the cases). Fifteen of the authors' series had lung abscesses clinically, while most of the patients showed lung destruction at autopsy. Meningitis and apical pneumothorax on the affected side occurred twice. Of 8 patients with pleural fluid, 3 had infected localizations. Three patients subsequently developed pulmonary tuberculosis. The adverse effects of suppurative disease on old and inactive tuberculosis has been emphasized by others.

The diagnosis of Friedländer pneumonia should be considered in all cases of pneumonia in adults where the etiology is uncertain. A Gram stain will reveal the organisms. An intraperitoneal injection of the patient's sputum into a mouse will cause death in twenty-four hours, with many characteristic bacilli in the peritoneal exudate and the heart blood.

The mortality rate in this series was 51 per cent. The rate varies with the number of lobes involved, and not with the age of the patient or the type of organism. Eighty per cent of the deaths occurred within five days of hospitalization.

The sulfonamides have some value when administered on the day of onset, but not thereafter. They probably have little value after suppuration occurs. Two patients had drainage of acute lung abscesses and did well. The chronic abscesses were treated conservatively, as most of the lesions will go on to fibrosis and healing.

BENJAMIN COLEMAN, M.D.

**Importance of the Lateral Film in Pneumonias of the Middle Lobe.** Rafael de la Portilla y Lavastida. Bol. de la Soc. cubana de pediat. 15: 38-46, January 1943.

After setting forth rather extensively the reasons

why a lateral chest plate should be made in the presence of pneumonia, the author presents two cases illustrating the points brought out in his discussion. He concludes that lateral chest roentgenography has demonstrated the greater frequency of pneumonia of the middle lobe, the fact that the roentgenographic image of pneumonias is always triangular, that the process always originates in the periphery, and that the most likely route of infection is the blood stream.

A. MAYORAL, M.D.

**Angiocardiography.** Harry M. Weber. Am. J. M. Sc. 205: 747-753, May 1943.

This is a review of the work of Robb and Steinberg and others on the demonstration of the heart and large vessels with the aid of a contrast medium. It brings together in concise form the scattered articles on the subject and lists the references.

**Calcification of Left Ventricular Infarction Recognized During Life.** Milton C. Borman. Ann. Int. Med. 18: 857-865, May 1943.

Calcified myocardial infarcts have been rarely found during life and still more rarely proved at necropsy. This is the fourth case of its kind reported in the literature. It was first discovered by roentgen ray and was studied with heart tracings and the kymograph.

The patient was a white male, 74 years of age, complaining of cough and dyspnea. His blood pressure was 168/100. No murmurs were present. The electrocardiogram showed depressed RT wave in lead III, small Q in lead I, slurred R in leads I, II, and III. A chest roentgenogram revealed vascular pulmonary engorgement, cardiac enlargement to the left, and a dense ring-like area of calcification occupying the apex and lower third of the left border of the heart. This was believed to be a calcium deposit in an old infarct, subsequent to coronary occlusion, in the parietal wall of the left ventricle. Kymographic studies demonstrated an almost complete absence of ventricle pulsations, about midway between the base and apex.

Necropsy revealed a prominent bulging of the left ventricle, extending from the anterior to the posterior wall *via* the apex. When the ventricle was opened it was found that the area observed on its external aspect corresponded to the wall of an aneurysmal dilatation. Plaques of calcification were embedded in the wall between layers of scar tissue and remnants of myocardium.

The author calls attention to the fact that a diagnosis of cardiac aneurysm is seldom made, although according to Parkinson (Quart. J. Med. 7: 455-478, 1938) aneurysm follows infarction in 9 per cent of cases. The present case would have escaped discovery without roentgen examination.

STEPHEN N. TAGER, M.D.

**Enormous Aortic Aneurysm, Partly Dissecting, with Heart Wall Aneurysm.** L. Bischoff. Schweiz. med. Wchnschr. 73: 714-715, May 29, 1943.

A 67-year-old syphilitic had clinical and roentgen signs of aneurysm. The chest film (reproduced in the article) showed an aneurysm filling two-thirds of the upper half of the chest and a left ventricle with an almost hemispherical contour, indicating a probable aneurysm of the heart wall. The electrocardiogram

showed coronary damage of the posterior wall type. At the time of the report the patient was still alive.

LEWIS G. JACONS, M.D.

**Aneurysm of the Right Pulmonary Artery with Rupture into Bronchus and a Patent Ductus Arteriosus: Report of Case.** Anton S. Yuskis. *California & West. Med.* 58: 272-275, May 1943.

Aneurysms of the pulmonary artery are rare. Of 144 cases recorded in the literature, 31 were diagnosed ante mortem (including the present instance). The increasing number of correct diagnoses is due to improved roentgen methods.

The cases reported have been more or less evenly divided between males and females. Thirty per cent were in persons less than thirty years of age, and about half the patients had other malformations. Various causes have been assigned for pulmonary aneurysms, including increased pressure within the pulmonary circulation plus arteriosclerosis, syphilis, rheumatic fever, trauma, and congenital defects.

The most commonly observed clinical features are prominence of the left side of the chest, especially in the second and third interspaces, pulsation, systolic thrill, impaired resonance, and a harsh systolic murmur. Right cardiac enlargement may be observed, and electrocardiograms may reveal right axis deviation. Fluoroscopic and roentgenographic studies are of great importance. They show a prominence of the pulmonary arc on the left border of the cardiac silhouette, which pulsates synchronously with the aorta or "see-saws" with the left ventricle, tending to obliterate the "aortic window." Death is generally due to rupture of the aneurysm, congestive heart failure, or septic endocarditis.

The author reports a case of congenital aneurysm of the right branch of the pulmonary artery with rupture into the bronchus and a patent ductus arteriosus. An ante-mortem diagnosis was made by x-ray and confirmed at necropsy.

**Chronic Empyema Due to Dermoid Tumors of the Mediastinum.** John M. Dorsey. *Surgery* 13: 755-761, May 1943.

The causes of chronicity in thoracic empyema have been listed as: inadequate drainage, presence of foreign bodies, communication with the lung, cavities that cannot be spontaneously obliterated, and tuberculosis or fungus infection. The author emphasizes a sixth cause—dermoid tumors of the mediastinum.

Dermoid tumors of the mediastinum are called epidermoids when derived from ectodermal elements, true dermoids when there is in addition evidence of mesodermal derivation, and teratoma when derivatives of all three germinal layers are present.

Secondary infection sometimes constitutes a deceiving as well as a dangerous complication of these neoplasms and may mask their presence behind the clinical syndrome of chronic empyema. Infection usually occurs from rupture into the neighboring pulmonary parenchyma or bronchi as a result of pressure. Suppurative pleurisy may result which, even when adequately drained, will not be permanently cured because of the underlying pathologic process. This fact is emphasized by two strikingly similar case histories.

The patients were young women—28 and 30 years of age—with a long history of thoracic symptoms. In

each tube drainage had been instituted and a chronic sinus persisted. Subsequent surgical procedures revealed the presence of a dermoid tumor, which was successfully removed. Hair was present in each instance, and microscopic sections showed derivatives of ectoderm and mesoderm.

It is only by a carefully planned study that diagnosis of the underlying cause of chronic thoracic sinuses can be correctly made. Sputum and sinus discharges should be searched for tubercle bacilli, as well as for fungi. Roentgen examinations should be made in both the anteroposterior and lateral projections before and after the sinus is visualized by the injection of lipiodol. Diaphragmatic hernia must be ruled out. Bronchoscopy and endoscopic examination of the sinus may confirm a tentative diagnosis if hair, cholesterol, etc., are found.

Characteristically, dermoids are found in the anterior mediastinum, extending laterally and posteriorly as they enlarge. Because of the possibility of malignant change, early operative removal is advocated. The surgical approach in each patient must be individualized.

J. E. WHITELEATHER, M.D.

**Intrathoracic Neuroblastoma: Case Report.** Walter E. Lee and Joseph A. Ritter. *Ann. Surg.* 117: 93-99, January 1943.

Neuroblastoma is the most common type of neurogenic tumor in infants and children. It can occur wherever sympathetic nervous tissue is present, but is most commonly found in the abdomen. The tumor may arise in the medulla of the adrenal or any of the ganglia extending from the cervical area to the pelvis. Roentgenologically, in thoracic neuroblastomas, a dense rounded shadow lying in the posterior portion of the chest is of diagnostic importance. The symptomatology is often negligible until pressure symptoms develop or metastasis occurs. In some reported cases there were manifestations similar to those found in adrenal chromaffinoma: tachycardia, profuse perspiration, vomiting, excitability, etc. These latter symptoms were present in the case reviewed by the author. In certain cases aspiration biopsy is indicated, and, in fact, may be beneficial, as neuroblastomas have been known to undergo spontaneous resolution after hemorrhage.

Once the diagnosis is established, even in the presence of metastases, surgery and irradiation are advisable. The experiences of Ladd and Gross and of Wyatt and Farber have definitely shown that the prognosis is not hopeless even though only a part of the primary tumor is removed.

A case is reported by the authors in an infant of five months. The symptoms and signs were very puzzling and the correct diagnosis was made only after aspiration biopsy under fluoroscopic guidance. The autopsy findings are presented.

P. C. BRIEDE, M.D.

**Extraordinary Calcification in the Breast.** Benjamin W. Anthony and Herbert C. Pollack. *Am. J. Roentgenol.* 49: 600-602, May 1943.

The authors present a case of extensive calcification of almost the entire right breast in a colored female aged sixty-six. The history suggested that these changes were the result of trauma and hematoma formation occurring seventeen years previously. Calcification may occur in the breast in association with ade-



noma, cyst, hematoma, mammary tuberculosis, psammocarcinoma, necrotic areas of mammary carcinoma, calcinosis universalis, and osteitis deformans. It is much more common in benign than in malignant lesions.

Oblique and lateral roentgenograms are reproduced showing the radiating trabecular arrangement of the calcifications and associated ossifications in the authors' case.

CLARENCE E. WEAVER, M.D.

## THE DIGESTIVE TRACT

**Roentgenology of the Digestive Tract in the Tuberculous.** John L. Kantor. *Am. Rev. Tuberc.* 47: 484-492, May 1943.

The author reviews the roentgen findings of tuberculosis of the various portions of the digestive tract. In the esophagus intrinsic tuberculous lesions are rare, and this is true of the stomach as well. In autopsies on patients dying of tuberculosis at Montefiore Hospital in the last 25 years, there were only two cases of gastric tuberculosis.

The study of tuberculosis in the small intestine offers an interesting and promising field to the roentgenologist. When the lacteal drainage of the small intestine is damaged by tuberculous disease of the mesenteric lymphatics so that fat absorption is impaired, steatorrhea may result. The condition is comparable to that occurring in sprue, and x-ray study may reveal a smoothing out of the valvulae conniventes in the jejunum and occasionally in the duodenum as well, to which the name "moulage sign" has been given. The roentgenological technic requires the frequent observation of the passage of a standard opaque meal through the entire small intestine, covering usually a period from three to nine hours after ingestion.

Tuberculous ulcers of the intestines are located chiefly in the ileocecal region. The roentgen diagnosis of tuberculous enterocolitis in the ileocecal region has not been highly accurate. In a series of 67 cases observed at Montefiore Hospital, in which the roentgenologic findings were controlled at necropsy, it was found that in only 32 instances, or 48 per cent, results of both methods coincided precisely. One of the reasons for this discrepancy is the fact that individual ulcers in the lower intestine cannot be demonstrated roentgenologically and the diagnosis, therefore, is presumptive, usually based on indirect signs such as increased irritability or spasm. To be significant, the area of filling defect due to irritability or spasm should involve the cecal colon, since this is the region where tuberculous ulceration is most likely to exist. Secondly the irritability must be shown to be constant or at least repeated.

The direct diagnosis of intestinal tuberculosis is based on the demonstration of roentgen abnormality caused by the lesions themselves. Such appearances are rare. The distinctive characteristics of tuberculosis are that the cecal colon is always irritable and in cases of tuberculoma the deformity is of a fixed and constant pattern. In differential diagnosis regional ileitis can usually be distinguished by the fixed deformity in contour of the terminal ileum, a dilatation of iliac loops proximal to the deformity, and the presence of a "string sign," which has not been observed in intestinal tuberculosis.

L. W. PAUL, M.D.

**Peptic Ulcer in Childhood.** Albert B. Newman. *Am. J. Dis. Child.* 64: 649-654, October, 1942.

The importance of the consideration of peptic ulcer and roentgen examination in cases of obscure abdominal pain in children is discussed. Over 50 cases have been reported in the literature. The author reviews the etiological possibilities with the conclusion that the cause of the disease in the child, as in the adult, remains obscure.

That peptic ulcer in childhood is rare is brought out by many reports. Perry and Shaw, for example, found 70 cases in 17,650 autopsies. Distribution between the sexes is about equal in contrast to male preponderance in adults.

Six cases are reported which bring out the similarity to the adult disease in the prepuberal age group. In the younger children, night pain or pre-breakfast pain was uncommon and tenderness was usually periumbilical rather than epigastric.

The diagnosis of peptic ulcer in children is basically roentgenologic, the roentgen changes being the same as in adults. The chief complications are hemorrhage and pyloric obstruction. In general, the outlook for healing is excellent. The routine alkaline therapy is used. Subtotal gastrectomy may be resorted to in cases of chronicity or recurring hemorrhage, but is seldom necessary. GEORGE M. WYATT, CAPT., M.C.

**Cancer of the Stomach: with Special Reference to Early Diagnosis.** I. W. Held and Irving Busch. *Ann. Int. Med.* 18: 719-735, May 1943.

Carcinomas of the stomach may be divided into two main groups: (1) those arising on a healthy gastric mucosa and (2) those originating in a previously diseased mucosa.

(1) Of the first group, which comprises about 70 per cent of the total, certain types are slow-growing and metastasize late, and to these the authors devote considerable space, describing the symptomatology and roentgen findings in some detail. *Cancer of the pars media*, involving both the anterior and posterior walls, produces the typical hour-glass picture. The edges of the constricted portion are irregular, and the canal between the upper and lower parts of the hour-glass is centrally situated in contrast to the canal of hour-glass due to ulcer, which is on a line with the lesser curvature. Also, in cancer the upper sac fills only partially with barium and therefore is smaller than the lower sac. The rapid passage of food into the duodenum is an important finding in *pyloric cancer*. The pylorus appears as a rigid tube, peristaltic waves may be diminished or absent in the pyloric region, and there is a conspicuous absence of antral contraction. Occasionally cancer is limited to the *posterior wall and lesser curvature* of the stomach. In most of these cases the lesion is a slowly growing scirrhus type and the roentgen studies reveal a rigid *pars media*, absence of peristalsis, and sometimes actual deformity of the *pars media*. *Cancer of the cardia* may be extremely difficult to detect roentgenologically. Films should be taken in every possible position and every effort should be made to demonstrate the air bubble, as its deformity is an important sign of cancer in this region. The authors conclude the discussion of these slow-growing cancers with a description of *scirrhus carcinoma* involving the entire stomach. The stomach appears as a narrow rigid tube transversely placed well above the umbilicus. Fluoroscopically the barium



is seen to pass through so rapidly that within less than an hour the entire stomach is empty. The air bubble is small or wholly absent. Often the barium is regurgitated into the esophagus, and the stomach and esophagus appear as two tubes, one vertical and one transverse. These slow-growing cancers, the authors believe, should be subjected to surgery even though a large palpable mass is present, for though the immediate mortality is as high as 10 or 15 per cent, lasting and good results may be expected if the operation is successful.

The medullary type of gastric cancer also arises, as a rule, on previously healthy mucosa, but grows rapidly and metastasizes early, mainly to the neighboring lymph nodes and liver. Roentgen examination shows an eaten-out pars media extending to the pylorus. Operation in these cases is attended by a high mortality but may produce worthwhile palliation if the patient survives. The small group of cancers metastasizing by way of the blood stream are not amenable to surgery.

(2) The second large group of cancers, those arising in previously diseased mucosa, tend to develop more slowly and to be more benign in character and therefore offer a better prognosis. The precancerous symptoms vary in nature, are usually bizarre, non-characteristic, and generally interpreted as neurogenic. Three separate groups of clinical entities are listed, on the soil of which cancer may develop.

(a) *Gastritis*: The gastroscope may establish the presence of early cancer before a roentgen diagnosis is possible, thus enabling prompt surgical intervention, with a possible permanent cure. Roentgen evidence of stiffening of the pars media and pylorus or very active or complete absence of peristalsis in this region justifies surgical exploration. A narrowed pylorus in conjunction with anaclidity is particularly suspicious of cancer.

(b) *Polyps*: Congenital polyps may be single or multiple, and pedunculated. They are less important from the standpoint of cancer development than the acquired type, which originates on a basis of gastritis. Gastroscopy and biopsy are the conclusive diagnostic methods.

(c) *Gastric Ulcer*: Whether cancer can develop subsequent to an ulcer is a moot question. The authors believe that an ulcer may actually precede the development of a cancer. Furthermore, a cancer can begin with ulcer symptoms, even without the presence of an ulcer.

As to the criteria in determining whether an ulcer has become cancerous, the authors discuss at length the significance of the niche, quoting various authorities and citing illustrative cases. They conclude that the chief emphasis should be placed on the persistence and aggravation of symptoms. Patients with ulcer symptoms, without ulcer signs, should be observed with greater suspicion and more watchfulness for early cancer than those in whom ulcer is clinically and roentgenologically demonstrable.

STEPHEN N. TAGER, M.D.

**Diverticula and Variations of the Duodenum.** Wolfgang Ackermann. *Ann. Surg.* 117: 403-413, March 1943.

Plaster of Paris casts of the duodenums of 50 cadavers were made and injected with methylene blue to determine the relation of the ampulla of Vater to the duodenum. The cadavers were selected at random.

Illustrations of eleven specimens with a total of fourteen diverticula are included. Twenty-two per cent of the series had duodenal diverticula, the highest incidence so far recorded. The distribution was as follows: none in the first part of the duodenum, five in the second part, one between the second and third part, five in the third part, and three in the fourth part. All were on the concave or pancreatic border and the majority were globular in shape.

The author quotes Maclean, Scott, McKinney, Costello and other authors regarding the roentgenographic diagnostic procedures and limitations. He concludes that, in spite of numerous technical difficulties, these anomalies are quite frequently discovered interest on the part of the roentgenologist in the particular subject are, however, essential.

Incidentally it was observed that the papilla is not constant in its location, occurring at the lower bend of the descending portion of the duodenum, at the medial side, and at the posteromedial side. It was also found that the duodenum is not infrequently made up of three parts instead of the classical four and that it may vary as to configuration and size.

A bibliography of more than 100 references is appended.

H. L. VAN HALTERN, M.D.

**A Case Successfully Treated by Duodenoduodenostomy.** Atresia of the Duodenum. Charles S. Ward, Jr., and Frederick W. Cooper, Jr. *Ann. Surg.* 117: 718-722, May 1943.

The authors present a case of atresia of the second portion of the duodenum successfully treated by duodenoduodenostomy at the age of five days. This is the only case recorded treated in this manner and the fifteenth in which a patient with complete duodenal atresia survived. The 14 previously reported cases, in which various anastomosing procedures were employed, are tabulated, the sites of obstruction and types of anastomosis being listed.

The authors stress the location of atresia in relation to the ampulla of Vater as a determining factor as to the type of surgical procedure to be used. They also emphasize the importance of preoperative and post-operative care.

Reproductions of roentgenograms illustrate the article.

H. L. VAN HALTERN, M.D.

**Chronic Partial Intestinal Obstruction Due to Intussusception of an Appendix Epiploica.** Maurice S. Harte. *Surgery* 13: 555-559, April 1943.

The unusual pathologic course of events in the clinical history prompted the report of the following case.

A white man 56 years old had for twelve weeks observed a change in his regular bowel habits. He gave a history of mild left lower quadrant abdominal discomfort, constipation, a dry, thin stool, slightly blood-streaked at times, and a free passage of flatus but no nausea or vomiting. A loop of distended bowel was visible in the left lower quadrant but there was no mass, tenderness, or rigidity. The intestinal mucosa appeared normal on sigmoidoscopy. Roentgen studies, repeated on three occasions, revealed complete obstruction at the mid sigmoid, with a filling defect at that point, which was believed to represent typical carcinoma. At operation a puckering of the pos-

teromedial wall of the sigmoid was observed with what at first was thought to be a submucous lipoma about 3 cm. in diameter almost completely obstructing the lumen of the bowel. The proximal colon was dilated; the distal colon was normal. There were no palpable lymph nodes and the liver was normal. Closer inspection proved the lesion to be an invagination or, better, an intussusception of an epiploic appendage into the bowel, causing an almost complete obstruction. Palpation through the wall of the bowel indicated the mucosa was ulcerated. Since there was no proof that the mucosal lesion was benign, it was decided to excise the segment of bowel.

In the center of the resected portion of the sigmoid was a puckered mass which had carried along with it an epiploic appendage. The part which had become invaginated consisted of a partially necrotic mass which was roughly spherical in shape and measured 3.5 cm. in diameter. The mucosal surface was greenish and necrotic at the head of the mass but at the base was granular and moderately inflamed. The mass was found on microscopic study to consist of fat tissue. Its surface was covered by a thinned-out muscular layer of intestinal wall.

Several theories are suggested to account for the unusual invagination observed in this case. A plausible one is that a submucous lipoma or polyp may originally have been present, attached to the bowel wall at the site of the ulcerated mucosa covering the invaginated portion. The dragging action of the fecal stream upon this growth gradually increased its length and narrowed the neck of the pedicle, at the same time tending to invaginate the wall at its base. This could weaken the muscle layer of the wall at the area subadjacent to the base of an epiploic appendage and thus invaginate the appendage. Continued pull of the fecal stream could pull off the polypoid growth, leaving an ulcerated mucosal base which persisted.

The author was able to find no similar report in the literature until after the acceptance of his case for publication, when 3 examples of intestinal obstruction caused by epiploic appendages were published by Giffin, Manamy, and Waugh (*Arch. Surg.* 45: 351-360, 1942).

J. E. WHITELEATHER, M.D.

**Microscopic Diagnosis of Radiopaque Substance in the Vermiform Appendix.** S. Sanes and John Ambrusko. *Surgery* 13: 561-568, April 1943.

In 1937, the curiosity of the authors was aroused by a peculiar content, observed microscopically, in the lumen of an appendix which had been sectioned following removal at operation. The content was interpreted as radiopaque substance received by the patient at some time for roentgen examination. This interpretation was subsequently confirmed.

From Oct. 1, 1940, to Sept. 30, 1941, 10 cases were found at the Buffalo General Hospital which showed microscopically what appeared to be barium sulfate in the appendix. All these patients had had a gastroenteric study or barium enema within eight days before operation. From Oct. 1, 1940, to Sept. 30, 1941, at the Buffalo Children's Hospital 4 specimens were obtained which contained what appeared to be barium sulfate, the longest interval between gastroenteric study with barium and operation in this group being five days. From September 1939 to October 1940, 3 specimens were obtained at the Niagara Falls Me-

morial Hospital which appeared to contain barium sulfate. In one of these cases a gastro-intestinal series had been made 44 days before operation; in the others the interval was two, six, and four days, respectively. These 17 specimens were found among 1,395 appendices examined at the three hospitals.

Various means were employed to check the microscopic observations. Roentgen studies disclosed that, if present in sufficient amount, radiopaque substance may be demonstrated in the lumen of the appendix by x-ray films of slides made for histologic examination. In the gross specimen the substance appeared as a white opaque substance. With strong central illumination, barium sulfate appeared in sections on the microscope as glistening, green-gray, refractile, more or less amorphous material. It also appears as a glistening substance on darkfield illumination.

The interpretation of certain signs in radiographic study of the appendix has elicited considerable difference of opinion. One view holds that the normal appendix should generally be visualized during a gastro-intestinal examination and that absent or incomplete filling by radiopaque substance is evidence of disease. On the other side, it is maintained that the "normal appendix is visualized only by the opportune coincidence of its filled condition to roentgenographic fluoroscopic examination. Nonvisualization never necessarily means an occluded and nonfillable appendix." In this study the presence of barium sulfate was shown in the lumen of one appendix which had not been visualized in routine radiographic examinations on three occasions.

The microscopic diagnosis of barium sulfate along with the roentgenograms of the extirpated and embedded appendix appears to offer a new and simple method, at least in one group of cases, to check the frequency with which barium sulfate enters the lumen without detection by the roentgenologist.

In this group of cases barium sulfate was shown to have been retained in the appendix from two to forty-three days after ingestion or enema. Two questions arise. Is retention a direct histopathological finding indicative of disturbance in evacuation of the appendix? How far can it be correlated with the radiographic picture of "chronic appendicitis?"

In only one of 13 patients did the appendix show evidence of active inflammation, the remainder showed fecaliths, retrocecal position and adhesions, or "nothing remarkable." Since 3 of the cases were adjudged "not remarkable" within the scope of pathological criteria, this finding might be used to support the idea that "mere prolonged isolated filling of the appendix after the rest of the colon is free of barium cannot in itself be considered as evidence of pathological condition." Yet this may actually signify a disturbance of evacuation due to impairment of motility or to augmentation of normal physiological obstruction rather than to obvious mechanical obstruction.

J. E. WHITELEATHER, M.D.

**Right Diaphragmatic Hernia of the Colon Through the Hiatus of Morgagni, in a One-Year-Old Mongolian Idiot.** Teodosio Valledor and Domingo Gómez Tejera. *Bol. de la Soc. cubana de pediat.* 15: 51-69, February 1943.

The authors believe the type of hernia described here to be rather rare, as only a few such cases have been reported. They think that the condition had its

incipiency following a cold accompanied by severe cough and seizures of asphyxia, when the child was ten months old.

The hernia was diagnosed roentgenologically, and excellent roentgenograms accompany the report.

A. MAYORAL, M.D.

**Blast Injury to the Abdomen by Depth Charge.** D. Denham Pinnoek and Paul Wood. *Brit. M. J.* 1: 537-538, May 1, 1943.

The authors present an account of 5 cases of abdominal injury incidental to blast, which is quite timely since little information has thus far been published on this subject, attention having been given mostly to hemorrhagic lesions of the lung in this connection.

The patient's description of his symptoms suggests a violent blow to the stomach. Most victims felt as though they had been kicked. Those swimming from an abandoned boat in the vicinity of a depth charge suffered violent cramps but were generally able to swim to help. Death resulted in 4 out of the 5 cases. The chief pathological findings were perforations of both colon and small intestines.

Q. B. CORAY, M.D.

### THE SKELETAL SYSTEM

**Post-Traumatic Necrosis of Bone.** Raymond W. Lewis. *Am. J. Roentgenol.* 49: 593-599, May 1943.

Posttraumatic septic bone necrosis is encountered rather frequently in an active bone and joint service. Its most usual occurrence is following fractures and dislocations. It is seen occasionally, however, after less serious injury. It may occur as a result of repeated small traumata such as those incurred in ballet dancing. The most frequent site appears to be the upper extremity of the femur, with the carpal bones, tarsal bones and ankle, and elbow following in the order of frequency. In many instances changes are evident on the roentgenograms within a few months of the injury.

The author quotes Phemister (*Arch. Surg.* 41: 436-472, 1940) in his description of the pathological processes following aseptic interruption of circulation in bone. From the surrounding living bone and joint structures there is fibrous invasion, with metaplasia and replacement of the dead bone by new bone. This is called "creeping substitution." When the cause of necrosis is a fracture followed by non-union, resulting in a considerable degree of disuse, there is enough atrophy of the adjacent living bone in one or two months to cause it to cast, in roentgenograms, a shadow fainter than that cast by the dead bone, which retains its original density.

During the period of bone necrosis and creeping replacement, the strength of the bone is greatly diminished and it cannot perform full function without danger of collapse, without danger of destruction of the anemic overlying articular cartilage. A permanently damaged joint then seems inevitable. Hence the importance of recognizing the existence of deficient blood supply and taking measures to protect the injured part.

Nine roentgenograms with appended case histories illustrate the circulatory disturbances described, while another shows a similar picture produced by Gaucher's disease.

CLARENCE E. WEAVER, M.D.

**Osteochondritis Dissecans: A Discussion of Two Similar Lesions.** C. W. Dawson. *Arch. Surg.* 46: 635-638, May 1943.

Osteochondritis dissecans is an aseptic necrosis of subchondral bone and the overlying cartilage, most frequent in young men, and incited by trauma. A somewhat similar condition, also called by some osteochondritis dissecans, is seen in older persons. It usually follows operation or trauma and consists in erosion or fibrillation of cartilage with eburnation of the subchondral bone. In no instance has the author seen this condition associated with osteochondromatosis. Diagnosis is dependent on a careful roentgen examination, since the clinical symptoms are not characteristic.

As the underlying factor in both lesions seems to be an aseptic necrosis with involvement of the cartilage and subchondral bone, they are both properly designated osteochondritis dissecans, but the second type might properly be called degenerative osteochondritis dissecans. The treatment of the two types is identical, consisting of surgical smoothing of the articular surface, with removal of loose fragments and overhanging shelves. Three cases are briefly reported to illustrate these points. Illustrations are included.

LEWIS G. JACOBS, M.D.

**Critical Analysis of the Roentgen Signs of Infantile Scurvy.** Ralph S. Bromer. *Am. J. Roentgenol.* 49: 575-579, May 1943.

In 1928 the author attempted to enumerate the roentgen signs of infantile scurvy and to arrange them in sequence so that four stages would show the progress of the disease as demonstrated in the roentgenogram (*Am. J. Roentgenol.* 19: 112-125, 1928. *Abst. in Radiology* 13: 184, 1929). In the early stages he described the ground-glass appearance of the shafts, the dense zone of temporary calcification at the end of the diaphysis, and the "pencil-point atrophy" of the cortex. This was followed by the appearance of a zone of decreased density behind the zone of temporary calcification. Later, well developed subperiosteal hemorrhages were shown, and so-called epiphyseal separations occurred. In the final stage the repair of scorbutic lesions with absorption of the subperiosteal hemorrhages was described.

More recent literature on infantile scurvy and experience with the disease are discussed, and the question is raised whether the earlier classification into stages is warranted. It is known that none of the signs is pathognomonic except the subperiosteal hemorrhages. Park and his associates (*Arch. Dis. Childhood* 10: 265-294, 1935) described a slight rarefaction and indentation at the distal border of the diaphyses of the radius, ulna, and tibia, and in the upper end of the humerus, which they called the "corner sign." The distal end of the femur showed this sign when the scorbutic process was well advanced. They conclude that there are no early roentgen signs of scurvy.

The author feels, however, that even if the ground-glass appearance and thinning of the cortex are not early signs, they nevertheless are useful in making a diagnosis of scorbutic atrophy previous to the roentgen recognition of subperiosteal hemorrhages and even before the clinical diagnosis is possible.

CLARENCE E. WEAVER, M.D.

**Concomitance of Chronic Acidosis with Late Rickets.** Julian D. Boyd and Genevieve Stearns. *Am. J. Dis. Children* 64: 594-607, October 1942.

A very complete case report is given of a girl aged 11 1/2 years with late rickets and chronic acidosis. She had had progressive weakness, difficulty in walking, and leg deformities for four years. Roentgenograms showed advanced active rickets. The calcium content of the serum was normal, but the inorganic phosphorus was 3.1 mg. per 100 c.c. and the phosphatase 71.5 Jenner-Kay units per 100 c.c. The chloride content and alkali reserve were each about half normal. These findings indicated serious disturbance in electrolyte metabolism. Dysfunction of the renal tubules was considered causative or contributory to the condition.

Upon a prescribed diet, vitamin D, and sodium bicarbonate, the patient was observed in the outpatient department for a period of three years. Roentgenograms showed complete healing of the rickets. The alkali reserve and phosphatase level became normal and the urine was free from albumin. Polyuria, fixed low specific gravity, and neutrality of urine, however, persisted. Improvement continued until the last period of hospitalization, at which time the child had 2 attacks of weakness and paresthesia, the last one terminating in death.

At necropsy no immediate cause of death could be found. The kidneys were essentially normal. The fundamental disturbance was thought to be extrarenal.

Regardless of the fundamental cause, the case illustrates the following sequence: (1) chronic acidosis causing (2) increased elimination of fixed base, resulting in (3) depletion of calcium reserves in the form of rickets; (4) prolonged response to simple replacement therapy consisting of oral administration of sodium bicarbonate. **GEORGE M. WYATT, CAPT., M.C.**

**Arthrogryposis Multiplex Congenita.** Miriam Katzeff. *Arch. Surg.* 46: 673-677, May 1943.

"Arthrogryposis multiplex congenita" is a term used to designate congenital contractures of the joints. First described in 1841 by Otto, it has also been called amyoplasia congenita and myodystrophia foetalis deformans. In seventeen years, this diagnosis was made in 18 patients admitted to the Children's Hospital in Boston. The ages of the children ranged from 5 days to 10 years and 7 months. In only one case was there a familial history. Various joints were involved, usually in the extremities; in 4 cases the spine was affected. Dislocation sometimes accompanied the contracture.

On physical examination, the affected extremities have a "stuffed sausage" appearance. Little muscle is palpable. Periarticular structures feel thickened and contracted. Dimples are frequently present over the patellas and elbows. Some passive correction of the contracture is usually possible. Deformities are symmetrical. Histologically there are atrophy and fatty replacement of the involved muscles. In the first few months of life roentgenograms show only deficient muscle shadows and increased density of the capsular areas; later secondary bony deformities appear.

Younger patients are usually treated by manipulation, with or without supports or surgical correction. Older patients require surgical correction of the deformity. Improvement is obtained in cases treated early.

One case is reported in detail, with illustrations. **LEWIS G. JACOBS, M.D.**

**Paratrooper Fracture.** William J. Tobin. *Arch. Surg.* 46: 780-783, May 1943.

Certain fractures are associated with a specific form of injury. A new type is here reported, which has been observed in a substantial proportion of the fractures sustained by paratroopers at Fort Benning, Ga., in the last two years. It consists of fracture of the posterior articular margin (posterior lip) of the tibia, with or without associated fracture of the external malleolus and/or the internal malleolus. This fracture is comparatively rare in civilian life. It has not usually been severe. Open reduction was not required in any case seen by the author. Protection was probably afforded by the high boots worn by the jumpers. Treatment consists in immediate immobilization in plaster. In simple fracture of the posterior lip, the soldier was allowed to resume jumping on recovery—seldom under three months. Soldiers sustaining trimalleolar fractures were placed on a "permanent non-jump status." **LEWIS G. JACOBS, M.D.**

**Low Back Pain, Anatomic and Constitutional Aspects in Differential Diagnosis.** Harry E. Mock. *Wisconsin, M. J.* 42: 389-400, April 1943.

Prior to the days of specialization and roentgenology, "guess work" was the chief diagnostic method in low back pain. Today, criticism is directed to the manner in which low back pain, in patients with a traumatic history, no matter how trivial, is diagnosed as a nucleus pulposus derangement, or herniated disk, or thickened ligamenta flava. The author admits that a herniated disk may account for low back pain, but takes issue with the manner in which some neurosurgeons make the diagnosis. He is averse to the diagnosis of a disk lesion and the recommendation of surgery on a hurried physical examination, absence of roentgen studies, the presence of the so-called pathognomonic "sneeze-pain reflex," and omission of conservative treatment. Surgery should be limited to those who fail to respond to conservative measures; otherwise the procedure may ultimately fall by the wayside.

There are many causes for low back pain. Some of them are: (1) herniated disk; (2) faulty posture; (3) flat back; (4) gynecological disturbances, as uterine displacements or salpingitis; (5) urological disturbances, as floating kidney; (6) gastro-intestinal disturbances, as ptosis; (7) psychogenic factors; (8) sprain; (9) muscle spasm and imbalance of muscles; (10) use of appliances over long periods of time, prolonging disability; (11) lesions in the smaller articulations; (12) contraction of intramuscular fascia and aponeurosis covering the back muscles; (13) obesity; (14) change from an active to a sedentary life; (15) myositis; (16) spondylolisthesis, and other conditions.

Conservative treatment is recommended—bed rest on a hard flat mattress or a fracture board, sedatives, proper and adequate physical therapy, such as heat, massage, and corrective exercises. Hyperextension apparatus is recommended for flat back. If this treatment is unsuccessful, when repeated examinations fail to reveal other causes, when the psychogenic element has been eliminated, and if neurologic symptoms persist or increase, one is justified in making a diagnosis of a ruptured intervertebral disk and operating.

During the past three years 300 cases were examined. Approximately 200 were under treatment. Most of these were allegedly traumatic. The diagnosis of a disk lesion was made in only 2 patients. One refused operation, and in the second no herniated disk was found. The latter patient proved to be a malingerer, and recovery followed a financial settlement. Almost all of the patients recovered and returned to work within four to six weeks, while a few required months of treatment. The majority of the patients were of the Stiller (psychogenic) type. Metastatic cancer was found in 2, Pott's disease in 2, gallstones in one, a penetrating ulcer in one, and a chronic retrocecal appendix in one.

HENRY K. TAYLOR, M.D.

**Congenital Narrowing of the Lumbosacral Space.** Theodore H. Vinke and Edgar H. White. *Surg., Gynec. & Obst.* 76: 551-555, May 1943.

The authors believe that congenital narrowing of the lumbosacral disk occurs often enough to warrant its consideration as an asymptomatic finding, without associating such narrowing indiscriminately with herniated disk. In a review of films of 300 children from 5 to 15 years of age, there were found 3 cases of narrowing aside from those caused by specific disease. In all 3 cases associated anomalies (lumbarization or sacralization) were present. Williams, Willis, and Hodges and Peck are quoted in support of the belief that these anomalies are commonly associated with a narrow lumbosacral or first sacral space.

The authors report 6 cases of low back pain in adults, 3 presenting radiation of pain. All were improved or cured by conservative management, although all films revealed narrowing of a disk and anomalies of the 5th lumbar and/or 1st sacral segments. These writers are concerned over the widespread tendency to interpret diminished disk spaces with anomalies as evidence for ruptured disk.

Excellent roentgen illustrations are included.

EDWIN L. LAME, M.D.

**New Aspects of Spinal Injuries.** Arthur G. Davis. *Arch. Surg.* 46: 619-634, May 1943.

Although considerable misapprehension existed in the past about the treatment of spinal fractures, there are a number of points about which general agreement has now been reached:

(1) Hyperextension is generally applied in the reduction of spinal fractures.

(2) The vertebral centrum will form callus as promptly as other bones.

(3) In cases of paralysis, laminectomy occupies a place distinctly secondary to that of hyperextension.

(4) The Queckenstedt test is invaluable in determining subarachnoid block.

(5) Skeletal traction is a useful adjunct in cervical injuries.

(6) Since the posterior vertebral arches are capable of supporting the weight of the torso alone, the latter part of convalescence may be ambulatory.

(7) The anterior longitudinal ligament is the main "cheek-strap" opposed to excessive hyperextension.

Among the points of disagreement the first to be mentioned is the length of convalescence. All variants from immediate walking after reduction and application of a plaster jacket to six months in bed are practised. Since fissure fractures of the posterior arch are frequent

and cannot always be shown in radiographs, the first course seems unwise. Six weeks of recumbency is safe and leads to good results. The method of reduction of compression fractures is another source of disagreement; the author believes that foot suspension is simplest and satisfactory.

Diagnosis of posterior arch fractures by inference is necessary, since the roentgenogram cannot be depended on to show even gross fractures of the pedicles, articular processes, and laminae. Some films made on denuded spines cut with a Gigli saw are reproduced to demonstrate this difficulty. Oblique views are most apt to show such lesions. A false sense of security sometimes results from the normal appearance of these parts on a roentgenogram. A careful analysis of the alignment of the various parts will help protect the operator against this error of interpretation.

Experimental studies of the tensile strength of the anterior longitudinal ligament showed an average breaking point of 337 pounds. The maximum pull required in any case for reduction of a fracture was 80 pounds. This four-to-one factor of safety seems ample except in cases of hyperextension injury or of fracture dislocation.

Cervical luxation, caused by injuries such as an automobile whip lash, leads to painful conditions but often produces no definite roentgen sign. There may be a minimal forward displacement, a sixteenth of an inch or more; more significant is the abolition of the normal curvature in the lateral projection, usually with a slight suggestion of anterior angulation at one intervertebral space. The diagnosis often cannot be strictly proved, but splinting in hyperextension immediately is imperative to prevent root pains and traumatic arthritis. A collar should be worn for several weeks to several months. If one waits until obvious dislocation has occurred (the normal movements of the neck will eventually produce this, because of the rupture of the posterior ligaments), an extensive fusion will be needed to relieve the pain.

[While meticulous technic should lead to the diagnosis of a greater number of the posterior arch fractures than the author appears to consider possible, the unfavorable conditions under which many, if not most, roentgenograms of spinal fractures must be obtained make such technic impossible and lend point to his comments.—L. G. J.]

LEWIS G. JACOBS, M.D.

**Dislocation of the Knee: Report of Four Cases.** Randolph L. Anderson. *Arch. Surg.* 46: 598-603, May 1943.

Complete dislocation of the knee is relatively rare. There are five types: anterior, posterior, medial, lateral, and rotatory, named according to the direction of tibial displacement. There is always considerable tearing of the lateral and cruciate ligaments. The popliteal vessels are occasionally torn, with resultant gangrene necessitating amputation. Nerve injuries have been reported, and concomitant fracture is frequent.

Treatment is by gentle reduction under anesthesia, followed by immobilization in plaster. The duration of immobilization has not been well standardized among the various writers on the subject. Open reduction is occasionally necessary. Operative repair of the ligaments is seldom needed, and should be deferred until conservative measures have been given an adequate trial.

Four cases are recorded to illustrate these points. In one case closed reduction was not found possible, and open reduction was employed successfully. In another case amputation was necessary for gangrene.

LEWIS G. JACOBS, M.D.

Notes on an Early Bone Cyst. C. B. Bennett. Arch. Surg. 46: 608-610, May 1943.

A boy was first seen in May 1938, at the age of 9 1/2 years. A routine study of development included roentgenograms of the left knee, which appeared normal. On Nov. 3, 1939, another study showed a tiny bone defect in the tibia. By May 1940 this had enlarged to 3 × 3 mm. and by May 1941 a further considerable increase in size had occurred. On Aug. 15, 1941, the cyst was curetted and swabbed with 50 per cent zinc chloride. Films made Nov. 4, 1941, showed satisfactory healing. A pathologist diagnosed the scrapings as giant-cell tumor of bone.

LEWIS G. JACOBS, M.D.

Chloroleukemia (Clinical Case). Rafael de la Portilla y Lavastida. Bol. de la Soc. cubana de pediat. 15: 121-135, March 1943.

A case of acute hemocytoblastic leukemia of one month's duration when first seen was erroneously diagnosed clinically as acute articular rheumatism before observation of the blood picture. The patient had symmetrical tumors in the lower extremities which on x-ray examination showed periosteal changes simulating scurvy. Similar changes were present in nearly all the long bones.

The author mentions a case of leukemia reported by Pagniez in 1924 which showed evolution into chloroma following radiotherapy. He also quotes Feer as stating that chloroma is differentiated from leukemia by the generalized and extensive cell proliferation in the subperiosteal tissues and as calling attention to the existence of symmetrical tumors in chloroma, as well as to the acuteness and severity of the leukemia in mixed cases.

The author's case was not unlike the one cited and is suggestive of the intimate relationship between chloroma and leukemia. The importance of roentgen studies of the bones in leukemia is stressed.

A. MAYORAL, M.D.

Plasmocytoma of the Humerus. Mario Gómez Camejo and Antonio Ponc de León. Rev. med. cubana 53: 783-793, September 1942.

A case of plasmocytoma of the left humerus is presented. The patient was a man of 55, who suffered a pathological fracture. Healing and disappearance of the tumor followed reduction and roentgen irradiation, but after a year and seven months there was a recurrence, with generalization.

A. MAYORAL, M.D.

## THE GENITO-URINARY TRACT

Calcification of Renal Tumors. George Austen, Jr. Am. J. Roentgenol. 49: 580-586, May 1943.

Of 106 tumors verified by microscopic examination, 98 were malignant and 8 were benign. Only one benign tumor, a leiomyoma of the renal pelvis, showed abnormal calcification. Calcium deposits in the tumor tissue were demonstrated by roentgenologic and microscopic examination in 16 of the 98 malignant

cases; 14 of these were carcinomas of the renal parenchyma, 1 was a papillary carcinoma of the renal pelvis, and 1 was a leiomyoliposarcoma of the renal capsule.

The calcification in renal tumors, as seen in the roentgenograms, assumed various patterns, not in themselves distinctive. In two instances the calcium deposits closely resembled those of renal tuberculosis. Calcified areas in the papillary carcinoma of the pelvis were at first mistaken for pelvic calculi.

Of the 14 carcinomas of the kidney parenchyma showing calcification, 9 were of the so-called "hypernephroma" type, 2 were papillary adenocarcinomas, 1 tubular or alveolar carcinoma, and 2 small-cell carcinomas. Pathological sections of these tumors showed multiple areas of hemorrhage, necrosis, and cystic degeneration. Calcium was always deposited in or about these areas. Although the rate of calcification is extremely variable and not proportionate to the degree of hemorrhage, it is of interest to note that in patients having calcified tumors the duration of symptoms from the onset to the time of treatment was definitely less than in those with non-calcified tumors.

While the survival rate in cases without calcification is approximately 30 per cent, for those with calcification it is 15.3 per cent. It would thus appear that the prognosis of cases with calcification is less favorable than of those without calcification.

CLARENCE E. WEAVER, M.D.

## THE SPINAL CORD

Arachnoiditis (Diffuse Proliferative Leptomeningitis). Alex Blumstein and A. B. Baker. Ann. Int. Med. 18: 809-824, May 1943.

Spinal arachnoiditis embraces both localized and disseminated forms, which explains the exceedingly varied and complex clinical picture. The onset is gradual without fever, and the course is invariably subacute or chronic. The disseminated type produces a syndrome of multiple involvement of the spinal nerve rootlets, both anterior and posterior, but predominantly posterior. *Pain is the most distinctive symptom*, usually commencing over one or more spinal segments, later becoming bilateral and spreading over a wide cutaneous area, sometimes with concomitant hyperesthesia or diminished sensation. This rootlet involvement is due to impingement by the proliferative leptomeningitis. A cyst later may produce signs and symptoms of compression simulating a true neoplasm.

Roentgenographically the *arrest of iodized oil at multiple levels* is the most important diagnostic aid. A subarachnoid block without xanthochromia or increased protein is a highly suggestive corroborative finding. The onset of arachnoiditis is much slower than in encephalomyelocloradicitis. In the latter condition, subarachnoid block is rare and the course is much more benign.

The treatment of choice is exploratory laminectomy to demonstrate the leptomeningeal adhesions. The most favorable non-surgical therapeutic measure is radiotherapy. The spine is cross-fired with high-voltage radiation at various levels, as indicated by the sensory disturbance. One or more series of treatments are given depending upon the response. An individual dose of 100-150 r (in air) is given fractionally, until a total of 800 r (in air) are administered. The recurrences of pain may be relieved by a repetition of the treatment. The outlook for therapeutic improvement,



however, after the process is long established, does not appear promising either with surgery or irradiation.

The pathological findings, grossly, consist of a definite thickening of the leptomeninges throughout the length of the spinal cord. In the more involved area, the membranes are opaque and completely obliterate the underlying structures. Frequent intermedullary cord changes are present due to vascular narrowing and occlusion caused by proliferative perivascular reactions.

In conclusion, four cases with autopsy findings are well presented, one in a child of seventeen months.

STEPHEN N. TAGER, M.D.

## TECHNIC

**An Investigation Into Some Practical Aspects of Roentgen-Ray Stereoptics. Part I. A Fallacy in the Current Practice of Stereoroentgenography. Part II. Single-Film Stereoroentgenograms—A New and Simple Method of Stereoroentgenography. Part III. A Device for Measuring Depth in Single-Film Stereoroentgenograms.** Edward Klein, Milton Klein, Harold Klein, and Allen T. Newman. *Am. J. Roentgenol.* 49: 682-690, May 1943.

In Part I the authors point out that the roentgenogram does not afford an image of an object but its shadow. They have established by trial and error that if the shadow displacement is greater than  $3/8$  inch the average person viewing two roentgenograms through a stereoscope at reading distance will not be able to fuse the two images to obtain a sense of depth. For this reason, the displacement of the tube must be varied in each case to insure that no more than this maximum deviation be produced. Use of the interpupillary distance displacement of the tube is incorrect. A formula for calculating the displacement of the tube is given.

Part II describes in detail a method for producing a stereoroentgenogram on a single film. When this is viewed through polarized spectacles, a tridimensional view is obtained. It can be viewed by more than one person at a time, or be projected on a screen and demonstrated to an audience.

In Part III a depth grid is described for the localization of foreign bodies and the determination of spatial relationships. A horizontal-vertical grid is marked in square centimeters by crossing wires. The depth grid is a long metal rod to which short spokes are attached at right angles and arranged spirally around it. These spokes are spaced at equal distances apart and numbered. The depth grid is attached to the horizontal vertical grid at right angles and in contact with the object to be radiographed. A stereoroentgenogram is made and viewed through polarizing spectacles. This enables the observer to compare the object-image with the calibrated depth-image, since both are in the same stereoptical field. A method of calculation of depth by means of a polarized ruler is also described.

CLARENCE E. WEAVER, M.D.

## INJURIOUS EFFECTS

**Radiation Hazards During Roentgenoscopy.** Thomas N. White, Dean B. Cowie, and Alfred A. de Lorimier. *Am. J. Roentgenol.* 49: 639-652, May 1943.

The tests reported in this paper have been limited to conditions of horizontal roentgenoscopy, for it is

believed that the greatest exposure is incurred thereby. The studies included the consideration of primary roentgen radiation escaping from conventional "ray-proof" roentgen tubes and the various components of secondary radiation, such as that emitted from fluoroscopic shutters, shutter housings, table tops, the patient (*i.e.*, phantom), and fluoroscopic screen. Measurements were made at a sufficiently large number of locations to permit the construction of isodose (strictly speaking, isodose per unit time or isointensity) curves, showing graphically the distribution of the secondary radiation.

In horizontal roentgenoscopy it is quite possible for the operator's legs to be nearly as close to the roentgen tube as were the ionization chambers in this test. At this distance undesirably large readings were obtained before supplementary absorbing material was added to the tube housing. Qualitative or quantitative testings were accomplished with no less than thirty-six different tubes or tube units. In every instance some escape of roentgen radiation was demonstrated—thus confirming the fact that the term "ray-proof" is in contradiction to the fundamental properties of roentgen rays. Large amounts of secondary radiation emanate from the irradiated side of lead shutters. Unless this is cut off by a cone extending from the tube housing to the shutters, or by some equivalent shield, there is likely to be over-exposure of the shins and feet of the roentgenoscopist.

The radiation emitted from the table top and screen is ordinarily affected by the patient, but with no patient present the operator may still receive appreciable amounts. The radiation from a very light table top, such as the United States Army litter, is much smaller than that from a conventional table top of wood veneer with metal frame.

In agreement with previous investigators, it appears that the secondary radiation from the patient is of preponderant importance. Metal side panels, such as are found on substantial totally enclosed tables of the "heavy-duty" type, are very effective in cutting off the back-scatter from the patient and table top. The amount of secondary radiation from the patient increases rapidly with the size of the beam. When the primary beam is allowed to permeate those tissues nearest to the roentgenoscopist without any intervening portion between the limits of the beam and the lateral wall, the radiant intensity is about twice that which obtains when even so little as 3 cm. of tissue intervenes to filter the rays. This fact should serve as a warning against prolonged viewing of the lateralmost tissues of a patient.

If a lead protective apron and gloves are worn by the operator to supplement well designed built-in protection, he can realize security against roentgen radiation exposure, except for very limited portions of his body such as his arms and shoulders. Except for these parts, the exposures can easily be kept well below conservative estimates of the tolerance dose; well below 0.04 r per hour, with the consideration of continuous roentgenoscopic activity, or less than 0.1 r for a strenuous ten-hour day of intermittent roentgenoscopy. With any of the present-day equipment, a considerable exposure is incurred by parts of the body such as the shoulders—a quantity of the order of ten times the accepted tolerance dose.

A comprehensive bibliography is appended.

CLARENCE E. WEAVER, M.D.

## RADIOTHERAPY

### NEOPLASMS

**Roentgen Therapy of Malignant Neoplasms of the Skin.** Ernesto Fonts Abreu. *Rev. med. cubana* 53: 684-688, August 1942.

According to the author, 90 per cent of cutaneous epitheliomas, if not too far advanced, are curable. After mentioning the sensitivity peculiar to each type of epithelioma, he describes briefly his technic. The higher the kilovoltage, the greater the filtration employed and the greater the distance, resulting in increased penetration and improved clinical and cosmetic results. He has increased the distance formerly used—25 or 30 cm.—to 50 cm., and the filtration from 1 mm. copper to 2 mm. copper plus 1 mm. aluminum. With these factors he does not hesitate to give doses of 6,000 to 8,000 r. Treatment is given over areas of 1 to 3 sq. cm., 300 to 400 r daily except Sundays. In the more superficial lesions the dose is decreased to about 200 r. The total dose for small lesions varies between 4,000 and 6,000 r. According to the legends of the accompanying illustrations 200-kv. rays are used.

A. MAYORAL, M.D.

**Treatment of Congenital Hemangioma of the Skin.** G. S. Johnson and R. A. Light. *Ann. Surg.* 117: 134-139, January 1943.

Hemangiomata have been classified by Watson and McCarthy (*Surg., Gynec. & Obst.* 71: 569, 1940) into eight groups: (1) capillary hemangioma; (2) cavernous hemangioma; (3) angioblastic or hypertrophic hemangioma; (4) racemose hemangioma; (5) diffuse systemic hemangioma; (6) metastasizing hemangioma; (7) naevus venosus or port-wine stain; (8) hereditary hemorrhagic telangiectasis.

This article deals with capillary and cavernous types of hemangioma and their treatment with radon seed implantation. The technic employed by Brown and Byars has been followed, using one radon seed for each cubic centimeter of tissue. The content of the seeds varied from 0.25 to 1.0 millicurie, the amount of radon per seed depending on the size and location of the hemangioma. Seven cases are presented which were treated by this method. In 5 the lesions were on the face or lips and in 2 on the vulva. Pictures taken before and after treatment attest to the excellency of this method. In only one case was there any scarring, and this resulted from administering too large a dose for the type of hemangioma treated.

P. C. BRIEDE, M.D.

**Treatment of Vascular Naevi by Radium Emanation.** Desmond J. Riordan. *Irish J. M. Sc.*, December 1942, pp. 626-630.

MacKee's classification of nevi as (1) naevus flammeus or port-wine stain, (2) naevus vasculosus or strawberry mark, and (3) angioma cavernosum, is ideal from the point of view of radiotherapy, since the three types vary definitely in their response to radiation. The best results are obtained with naevus vasculosus. Naevus cavernosum is less responsive but is more sensitive than naevus flammeus.

For the treatment of vascular nevi gold seeds with 0.5 mm. filtration for interstitial radiation and silver seeds with 0.9 mm. filtration for superficial application

are used. For nevi on a flat surface, the radon is mounted on an elastoplast and felting applicator and then covered with elastoplast, delivering 2,000 roentgens in one week. This may be repeated at the end of one month and again at the end of three months. In such regions as the eyelids or lip, where the use of applicators is not practical, gold seeds are inserted temporarily or permanently, delivering 3,000 roentgens in one week; treatment not to be repeated. The author advises against the implantation of needles.

The distribution of radon on the applicator or in the tissues is according to a formula elaborated by Paterson and Parker in order to obtain homogeneous irradiation. A dosage chart is included.

HENRY K. TAYLOR, M.D.

**Melanoepithelioma (Melanosarcoma, Melanocarcinoma, Malignant Melanoma) of the Extremities.** W. H. Bickel, H. W. Meyerding, and A. C. Broders. *Surg., Gynec. & Obst.* 76: 570-576, May 1943.

The authors analyze 107 proved cases of melanoepithelioma of the extremities seen in the Mayo Clinic in a 24-year period. The age span was twelve to seventy-six years, over 50 per cent of the patients being between forty and sixty. Lower limb lesions constituted 76.7 per cent of the total. Obvious metastases were noted initially in 38.3 per cent, and these by way of all possible routes. The observation is made that primary or metastatic lesions may or may not be pigmented. Symptomatology is considered in detail.

Treatment results were as follows. Excision with or without irradiation produced 29.8 per cent five-year survivals from initiation of treatment. In many of these cases the lesions were early or small. Amputation with or without radiation, usually done in late or advanced lesions, yielded 21.1 per cent five-year survivals. Irradiation only was employed in just 15 cases, of which 11 had had surgery elsewhere; all of this group died in less than three years. The authors advise wide excision, with removal of regional lymph nodes, or amputation at the first diagnosis. Exceptions should be only those lesions in which no enlargement is discovered, and in these wide local excision is indicated.

This is an excellent and substantial paper, but treatment analysis has been from a surgical point of view, so that a real comparison between the results of surgery and radiotherapy cannot be made.

EDWIN L. LAME, M.D.

**Discussion on the Value of Irradiation in Association with Surgery in the Treatment of Carcinoma of the Breast.** Stanford Cade *et al.* *Proc. Roy. Soc. Med.* 36: 237-242, March 1943.

Cancer of the breast may be classified according to (1) the histological structure as papillary, intraduct, adenocarcinoma, scirrhous, or medullary, or according to (2) the clinical type as scirrhous, cnccephaloid, duct carcinoma, atrophic scirrhous, or Paget's disease of the nipple. These classifications aid in arriving at a prognosis, but of all the prognostic factors, extent is the most important. With this as a basis, the author uses the following classification: (1) tumor of the breast only; (2) tumor of the breast plus



skin changes and/or axillary nodes; (3) stage two and/or supraclavicular or contralateral axillary nodes or fixation to the pectoral fascia; (4) visceral or skeletal metastases (regardless of local extent).

Three sets of statistics for surgically treated cases are quoted. The most favorable are those of G. Gordon-Taylor, following radical mastectomy. These show 85.4 per cent three-year survivals for first stage cases; 46.8 per cent for the second, and 10.1 per cent for the third stage. The ten-year survival rate for this group was 81.07 per cent for the first stage; 29.1 per cent for the second; 6.5 per cent for the third.

The statistics of Keynes for interstitial radiation therapy are also quoted. The net survival rates were: at the end of three years, for the first stage 83.5 per cent, for the second stage 51.2 per cent, and for the third stage 31.4 per cent; and at the end of five years 71.4 per cent for stage one, 29.3 per cent for stage two, and 23.6 per cent for stage three. The author's own five-year survival figures in 213 cases after radium alone, or radium and surgery, are 87.7 per cent for the first stage; 29.6 per cent for the second stage; 25.4 per cent for the third stage.

An evaluation of the figures shows that cases in stage one do very well with any type of treatment. With surgery alone there is a 90 per cent mortality in stage three at the end of three years, while the combination of radium and surgery has increased the survival rate of stage three to 25 per cent at the end of five years.

The author concludes that in cancer of the breast a combination of surgery and radiotherapy is the treatment of choice. Skilled radiation therapy is no longer an *auxiliary* method, but of equal and, in some cases, of *greater* importance than surgery.

Dr. R. McWhirter, continuing the discussion, stated that the five-year survival rate in cases of carcinoma of the breast referred to large general hospitals is probably not more than 20 per cent with surgery alone, failure to eradicate the disease being due either to distant metastases, or failure to remove all malignant cells, or both. It is in the cases in which malignant cells are left at the operative site that irradiation may convert a potential failure into success.

In order to determine the value of postoperative radiation therapy, an investigation was undertaken in co-operation with the surgical staff of the Royal Infirmary in Edinburgh. The cases were divided into 4 groups according to the extent of disease. This classification differs slightly from that of Cade. The first 3 groups were in turn divided into 2 groups: one treated with surgery alone and the second by a combination of surgery and irradiation. Adequate postoperative radiation therapy consisted of a minimum dose of not less than 3,500 r, more often 4,500 r, in four weeks to an area including the supraclavicular region, the whole length of the axillary chain of nodes, and the chest wall on the affected side. The results indicated that a combination of surgery and postoperative radiation therapy yields better results than surgery alone.

Mr. J. Jackson Richmond also presented evidence which revealed the improved results obtained by a combination of irradiation and radical mastectomy. He recommended preoperative as well as postoperative irradiation. A small number of histologically Grade I cases can be treated safely by surgery alone.

HENRY K. TAYLOR, M.D.

**Roentgen Treatment of Cancer of the Esophagus.** D. W. Smithers, J. R. Clarkson, and J. A. Strong, *Am. J. Roentgenol.* 41: 606-634, May 1943.

In the introduction to this paper Smithers summarizes the reasons for failure of treatment of cancer of the esophagus due to the nature of the disease and the difficulties associated with the various therapeutic methods, *viz.*, surgery, teloradium, interstitial radium or radon, radium bougie, and roentgen irradiation. Roentgen treatment has much to recommend it, for it is the most effective method of securing palliation and at the same time causes the least discomfort.

In his account of roentgen treatment of esophageal cancer at the Royal Cancer Hospital (London) Smithers divides the cases according to the site of the tumor as follows: (1) postericoid tumors and tumors of the cervical esophagus; (2) tumors of the thoracic esophagus; (3) tumors of the abdominal esophagus and of the fundus of the stomach involving the esophagus.

To obtain an adequate tumor dose, multiple fields must be used, and it is clear that long narrow fields will give the best distribution. In tumors of the thoracic esophagus six fields are employed, arranged in three sets of directly opposing pairs: an antero-posterior pair measuring  $15 \times 6$  cm. each and two oblique pairs measuring  $15 \times 4$  cm. each, the fields being so arranged that the center of each anterior oblique field is 7.0 cm. from the mid-line and the central rays from all six fields meet at the center of the tumor. The tumor is localized by aligning it between two points on the surface in several planes, using the fluoroscopic screen. A cross-section drawing of the patient's chest is then made with the aid of a special apparatus. The skin marks made at fluoroscopy are reproduced on the drawing and joined by lines representing the central axis of the beams of radiation. This cross-section is used to determine the tumor dose due to a combination of the six fields selected. The patient is treated in the sitting position, with a specially designed apparatus for maintenance of position. A treatment is given daily to all six fields for five to seven weeks, usually with the following factors: 400 kv. peak; filtration 0.22 mm. Sn with 1.7 mm. Al added, the inherent filtration being equivalent to 2.0 mm. Cu, the half-value layer of the radiation being 3.7 mm. Cu; focal skin distance 80 cm.; dosage rate on the skin surface about 10 r/min. and at the tumor center about 3 r/min. The tumor dose is planned to be between 6,000 and 7,000 r in six weeks. In the average case this means a daily dose per field of 100 r. Any air spaces between portions of the applicator and the chest wall are filled with rice bags. The patient is examined a week or two after cessation of the treatment, by barium meal. Six to eight weeks later esophagoscopy may be performed. If there is a tendency to fibrotic constriction, careful and repeated dilatation should be undertaken.

In postericoid tumors of the pharynx and tumors of the cervical esophagus a directly opposing antero-posterior pair of fields measuring  $10 \times 6$  cm. is arranged. Two 7 cm. diameter circular fields are used on either side of the neck in the same anteroposterior plane as the tumor but angled downward and inward.

In tumors of the abdominal esophagus and of the cardiac end of the stomach involving the esophagus six fields measuring  $10 \times 6$  cm. arranged in three pairs are used.

Of 44 patients with esophageal carcinoma treated by roentgen rays from 1936 to 1939, 30 obtained some relief of symptoms and 11 complete relief. Of 15 patients treated during the first half of 1940, 7 have obtained some relief and 7 are symptom-free. In no case has fibrosis of the lungs developed. Skin reactions have been mild erythemas only. Of the series treated in 1936-39, 6 were alive at the time of the report, 1 after four years. Of those who died, 8 lived a year or more after treatment and 1 more than two years.

Part II of this paper, by Clarkson and Strong, is devoted to a detailed account of the physical measurement of the volume roentgen-ray dosage distribution due to elongated fields. The measurements of dosage were made in a water phantom of dimensions  $43.5 \times 42.5 \times 110$  cm.; 140 per cent isodose surfaces were worked out for 200 kv., 1.35 mm. Cu half value layer, 80 cm. focus-skin distance; also, for 400 kv., 3.7 mm. half value layer, 80 cm. focus skin distance. It was found that the surface obtained at 200 kv. is both shorter and narrower than for the more penetrating radiation and that the points of maximum dose tend to lie toward the front of the esophagus.

Tables, charts, and roentgenograms illustrate this paper.

CLARENCE E. WEAVER, M.D.

**Diagnosis and Treatment of Vesical Tumors.** Ricardo Portilla. Rev. med. cubana 53: 689-694, August 1942.

Portilla divided his investigation of tumors of the bladder into two parts, clinical and mechanical. He stresses the importance of the first but goes into greater detail concerning the second, which includes cystoscopy and roentgenography. After discussing the possible findings, he enumerates some of the pitfalls of diagnosis.

In treatment the general condition of the patient and superimposed infection, if present, call for first attention, to be followed by therapy aimed at destruction of the tumor. For small pedunculated tumors the author advises electrocoagulation or resection with the MacCarthy instrument. For small sessile lesions not over 3 cm. in diameter, located near the trigone, implantation of radon seeds in combination with electrocoagulation is recommended. In large pedunculated growths or multiple tumors, cystostomy with electrocoagulation is indicated, associated with radon implantation at the base. For sessile tumors or infiltrating lesions not involving the trigone, partial cystectomy is the method of choice. If the trigone is involved, total cystectomy should be done. In the presence of multiple papillomata and in advanced cases radiotherapy is used with good results for the relief of symptoms.

A. MAYORAL, M.D.

**Leukemia: Relative Incidence of Its Various Forms and Their Response to Radiation Therapy.** Frank H. Bethell. Ann. Int. Med. 18: 757-771, May 1943.

A series of 495 cases of leukemia, examined at the Simpson Memorial Hospital, Ann Arbor, Michigan, from July 1, 1927, to Dec. 31, 1941, is presented in tabular form, with respect to the sex and age of the patients and the relative frequency of various types. Three main forms are recognized: the *lymphogenous* (216 cases, or 43.6 per cent of the total); the *myelogenous* (239 cases, or 48.3 per cent); the *histogenous* (40 cases, or 8.1 per cent). The last is characterized by generalized proliferation of cells of reticulo-endothelial origin.

Monocytes are commonly found in the circulating blood of such patients.

A possible explanation for the progressive increase in the diagnosis of leukemia lies in the current use of sternal marrow examination in practically all suspected primary blood disorders.

The indications for radiation therapy in the myelogenous group (myelocytic and myelomonocytic leukemias) are symptoms of anemia, increased metabolism, pressure due to splenomegaly, and pain in or referred from the splenic area. The chronic forms of the disease give the best response and the myelocytic and lymphocytic varieties are most responsive to treatment. The degree of improvement, the duration of remission, and the elapsed time before occurrence of a refractory state cannot be foreseen in any individual case.

The plan of therapy has involved an intensive short course of treatments with exposure limited usually to the splenic area in cases of myelocytic and chronic myelomonocytic leukemia. The factors used are 200 kv., 25 ma., 50 cm. F.S.D., 0.5 mm. Cu plus 1.0 mm. Al filter, with a field of 100-150 sq. cm. A skin dose of 100 to 200 r is administered over the anterior, lateral, and posterior surfaces of the splenic area. The treatments may be given on consecutive days, preferably as rapidly as possible, except that not more than one field is treated during a 24-hour period.

Particular emphasis is placed on the differentiation of monocytic leukemia as related to the myeloblast and that form believed to derive from an undifferentiated reticulum cell or histioblast.

Three illustrative cases are mentioned, with excellent illustrations of pertinent hematologic data.

STEPHEN N. TAGER, M.D.

## NON-NEOPLASTIC DISEASE

**Clinical Classification and X-Ray Therapy in Acute Pulmonary Infections.** R. C. Curtis. Texas State J. Med. 38: 722-723, April 1943.

Among 150 cases of pneumonia treated with roentgen rays there were 5 deaths, a mortality rate of 3.33 per cent. Half of the patients also received sulfa drugs, and 3 of the fatalities were in this group. An earlier report (Powell: J. A. M. A. 110: 19-22, 1938. Abst. in Radiology 32: 382, 1939) from the same institution included 134 cases treated with x-rays and no sulfa drugs, with 9 deaths. The author combines both groups, making a total of 284 cases with 14 deaths, a mortality rate of 4.9 per cent. The 75 patients receiving chemotherapy showed no untoward effects from the combined treatment. The factors now used are 185 kv., 0.5 mm. Cu and 1.0 mm. Al filtration, 50 cm. distance,  $20 \times 20$  cm. field, 250 roentgens per dose at a rate of 25 r/m.

The favorable results to be expected are relief of labored breathing and pain and lowering of the respiration rate, pulse rate, temperature, and white count. The treatment is not used in the tuberculous. Complications were infrequent in the author's series. In his group of 150 cases, 64, or 42.6 per cent, required but one treatment, and the crisis occurred in forty-eight hours; 46, or 20 per cent, required two treatments, the crisis occurring in seventy-two hours; 35 required three or four treatments and their recovery was slower. Of 35 patients admitted to the hospital on the fifth to the fifteenth day, 5 had lung abscesses,

all of which had ruptured into a bronchus with spontaneous drainage and recovery. Three patients had pleural effusions, which resolved in every instance.

HENRY K. TAYLOR, M.D.

**Roentgen Therapy of "Virus" Pneumonia.** Alhert Oppenheimer. *Am. J. Roentgenol.* 49: 635-638, May 1943.

For the treatment of virus pneumonia, the following factors were used: 130 to 150 kv., according to the size of the chest and the thickness of the skin and muscles; 30 ma.; 0.5 mm. Cu plus 1.0 mm. Al filtration; 50 cm. anode-skin distance; an average dose of 50 r (measured in air) through portals covering the involved parts of the lungs, usually  $20 \times 30$  cm. The amount of radiation applied should increase with the duration of the inflammation (up to 90 r in adults). As a general rule, a single treatment was sufficient to bring about a return of temperature to normal within sixteen hours, as well as a considerable diminution of the cough and distress, in patients treated within a few days after the onset of symptoms. When treatment was begun after the disease had lasted for over a week, a second treatment, sometimes followed by a third after forty-eight hours, was necessary to obtain relief and bring the temperature to normal. Patients treated after termination of the febrile stage because of persistent cough at night, associated with fatigue and inability to resume normal occupation, were free of symptoms after three or four doses of 90 r in the course of two weeks.

Fifty-six cases were treated by the author. Only 11 patients were considered as not cured; 8 of these had been sick over fourteen days and 3 had had the disease six to fourteen days. The conclusion is reached that "it would seem to be evident that roentgen therapy helps to shorten the duration of the disease materially." Heavy dosage in the early stages should be avoided.

CLARENCE E. WEAVER, M.D.

## TECHNIC

**Discussion on the Technique of Radiotherapy.** B. W. Windeyer *et al.* *Proc. Roy. Soc. Med.* 36: 261-270, March 1943.

The subject of irradiation in laryngology is discussed in a general way by Windeyer, who mentions the indications for multiple small dose, single massive dose, and fractionated techniques, and outlines the general plan of treatment.

Constance Wood describes the radium bomb designed at the Radiotherapeutic Research Unit of the Medical Research Council. The apparatus has devices for localizing and accurately directing the rays and means for determining the number of roentgens delivered per hour at any given part. In treating carcinoma of the oral cavity and pharynx, the primary growth is irradiated through its lymphatic drainage in the neck. The details of the technique are illustrated in the treatment of a new growth on the posterior wall of the oropharynx, using 4 ports. The best results were obtained when 6,000 to 7,000 roentgens were delivered to the lesion in 42 days, with two treatments of 20 minutes each daily.

Ralston Paterson divides pharyngeal and laryngeal new growths into (1) squamous-cell carcinoma and (2) reticulo-endothelial new growths. Squamous-cell cancer, which is more frequent, requires precise localization because the fundamental need is to irradiate the smallest possible volume enclosing the tumor. The aim is to give as much radiation as will be tolerated safely. With a smaller field, a greater dosage can be delivered. Reticulo-endothelial growths, as lymphosarcoma, lymphoepithelioma, reticulum-cell sarcoma, round-cell sarcoma, etc., are highly radiosensitive. Large fields are used for irradiation of these growths. Good results are usually obtained if radical treatment, to the limits of tolerance, is administered before dissemination.

HENRY K. TAYLOR, M.D.

## EXPERIMENTAL STUDIES

**Studies on the Indirect Effect of Roentgen Rays in Single and Parabiotic Mice.** W. A. Barnes and O. B. Furth. *Am. J. Roentgenol.* 49: 662-681, May 1943.

The effects produced in exposed and non-exposed bone marrow of mice receiving 800, 2,000, or 6,000 r to the entire body except one leg varied but little qualitatively. The larger the dose, the earlier was the decrease of hematopoietic cells in the directly irradiated marrow noted. There was capillary dilatation in the unexposed marrow from three to five days after irradiation, but no decrease in the number of hematopoietic cells, except perhaps one to three days after 6,000 r. These experiments show that in mice, after a single exposure (with one leg shielded) to as much as 6,000 r, there are no conspicuous destructive effects in the non-exposed marrow after from three to five days. The significant changes in lymph nodes several hours after irradiation, slight in the shielded and marked in the exposed nodes, consisted of pyknosis and fragmentation of the nuclei of the lymphocytes. The authors were able to produce similar changes in the lymph nodes and bone marrow in mice burned by actual cautery over the abdomen and chest. The

changes are, therefore, not specific for indirect effects of irradiation. The magnitude of the indirect effect of irradiation is dependent, at least in part, on the volume of tissue exposed and not alone on the dose of roentgen rays.

The changes occurring in the blood-forming organs of a parabiont directly exposed to 800, 3,200, or to 6,000 r are similar but quantitatively less than those occurring in a single mouse similarly irradiated. After irradiation of its twin with 800 or 3,200 r, the non-irradiated parabiont shows no destructive changes in the blood-forming organs one to eleven days later. However, seven hours after its twin received 6,000 r, the non-irradiated parabiont showed pyknosis and fragmentation of nuclei of lymphoid cells. In spite of the initial damage, the non-irradiated mouse recovered almost completely within three days, whereas the irradiated twin showed persistent damage, consisting of aplasia of bone marrow and marked decrease of cellular elements of spleen and lymph nodes.

Experiments showed that when one member of a pair of parabiotic mice was irradiated with from 450 to 1,000 r there was leukopenia in the irradiated para-

biont. There was no leukopenia in the non-irradiated parabiont after exposure of its twin to 450 r. When its twin received 800 or 1,000 r, there was a moderate to marked drop in the leukocyte level of the non-irradiated parabiotic animal. The reduction of the number of leukocytes in the irradiated parabiont was less marked than in an irradiated single control and the return toward normal occurred sooner. Differential counts show that the decreased leukocyte level in the irradiated twin is due to a fall in both myeloid and lymphoid cells, more especially in the latter. The leukopenia in the non-irradiated twin similarly is

due largely to a lymphopenia. This can be explained either by passage of lymphocytes from the shielded to the irradiated animal or by transfer of a noxious agent from the irradiated to the shielded twin.

These experiments suggest the possibility that an animal united to another by parabiosis might survive larger doses of roentgen rays. A single mouse almost invariably dies following exposure to 1,000 r, but if joined to another mouse by parabiosis it may survive. Parabiosis diminishes the deleterious effects of irradiation.

CLARENCE E. WEAVER, M.D.



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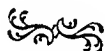
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